

12 **EUROPEAN PATENT APPLICATION**

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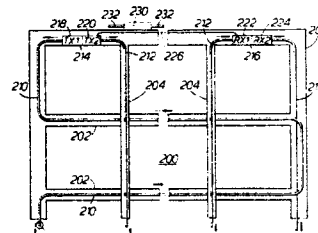
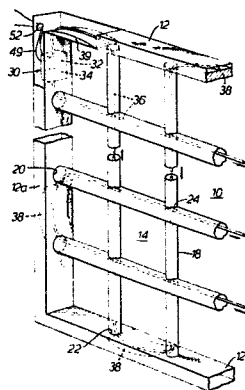
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54 **Security barrier structure.**

57 A panel for a security barrier has a rectangular hollow frame (12) within which is supported a lattice (14) of hollow tubular members that open into the hollow frame (12). A light source (32) and an optical receiver (34) are located in the frame and a fibre optic cable (36) provides a transmission path between the source (32) and receiver (34), the cable (36) extending through the hollow lattice members. Changes in the received light are used to generate an alarm signal. Preferably the fibre optic cable is multi-strand. In an alternative (Figure 4) two fibre optic paths (210 : 212) are provided, extending in zig-zag fashion through the two directions of the lattice. The frame and lattice are preferably of glass-reinforced polyester and are bonded by epoxy resin. The lattice members may intersect one another or may be arranged into contacting layers spray bonded at the points of contact.



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Title: Security Barrier Structure

FIELD OF THE INVENTION

This invention relates to a security barrier.

5 There is a continuing need for barriers to prevent access to areas or zones from which intruders are to be excluded. In addition to measures taken to physically prevent entry into such a zone through a barrier, there is need to monitor and signal attempts to force entry through the barrier.

10 BACKGROUND TO THE INVENTION

Particular problems arise where there are inlets to or outlets from the zone for say air or water, e.g. roof vents, cooling water inlets or outlets or sewers, where air or water is to flow through the barrier. To this end, a protective barrier can be made of a mesh or lattice construction. A mesh or lattice type of construction is in itself common for fences particularly where long runs are required, i.e., chain-link fencing. However, as will become clear hereinafter the construction employed in accord with the present invention is of a special nature.

It has already been proposed to employ an optical fibre as an intruder detector by monitoring the transmission of light along such a fibre. It has long been well known generally in the fibre optic art that transmission is not only interrupted when the optical fibre is broken but that a substantial interruption (attenuation) arises when such a fibre is distorted as by severe bending. It is well known in normal fibre optic communication systems to avoid unduly sharp bends.

This transmission property of a fibre optic

cable is used in a perimeter intrusion detector disclosed in British specification 2 053 544 where the optical fibre is laid on the ground. The same property is used in an optical fibre carried along a fence as disclosed in British specification 2 039 683 published 13th August, 1980. An earlier developed version of this fence system is disclosed in British specification 1 602 743 and its corresponding U.S. patent 4 275 294 not published until 18th November 1981 and 23rd June 1981 respectively. A different property of optical fibres is used in the intrusion warning system disclosed in British specification 1 497 995 where use is made of changes in optical propagation concomitant with acoustic disturbances propagated along an optical fibre. All these systems are intended for protecting an extended boundary. All extend essentially linearly along the boundary and are limited as to the area of space protected in so far as the perimeter may be penetrated one way or another. They are not well suited for the protection of inlets, outlets, or vents or other well-defined areas such as mentioned above.

SUMMARY OF THE INVENTION

It will be shown hereinafter how the present invention can be implemented to perform a dual function, providing a very rigid barrier structure, realisable in the form of panels out of which a larger construction can be assembled, and which uses a fibre optic sensing arrangement integral with the barrier structure and providing detection ability over the whole structure. Such a barrier, or combination of such barriers, has particular application in protecting a well-defined area, such as an inlet or outlet or vent mentioned above, and providing sensing over the whole of that area wherever penetration is attempted.

Broadly stated, the present invention now provides

a barrier structure comprising a hollow frame and a mesh or lattice supported within and by the frame and comprising hollow members whose interiors communicate with the hollow of the frame. An optical fibre cable
5 extends through at least some of the hollow members. A light source is located in the hollow of the frame and coupled to one end of the fibre cable to transmit an optical signal along the fibre, and an optical receiver also located in the hollow of the frame is
10 coupled to the other end of the fibre cable to receive light therefrom. The receiver includes means responsive to changes in the received optical signal to provide an output signal.

It will be understood that the frame is hollow
15 to the extent that it can accommodate the optical fibre cable in passing from one hollow member to another and that it can accommodate the receiver and transmitter.

The optical fibre cable may comprise a single fibre. However, a multi-strand cable is employed with
20 a particular benefit in cases where an extra high degree of proof against tampering is required.

The mesh or lattice of the barrier structure may comprise a first set of parallel members and a second set of parallel members at an angle to the first
25 with the optical fibre cable extending through members of both sets. Conveniently the frame is of rectangular structure with the first and second sets at right-angles and parallel to respective sides of the frame.

In an alternative arrangement for the fibre optic
30 monitoring, the barrier structure comprises a hollow frame with a mesh or lattice supported within and by the frame and comprising hollow members whose interiors communicate with the hollow of the frame. The hollow members are constituted by a first set of parallel members
35 at an angle to the first. First and second light sources

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and first and second optical receivers are located in the hollow of the frame. A first optical fibre cable extends between the first light source and first optical receiver to provide a transmission path
5 therebetween, and a single optical fibre cable extends between the second light source and the second optical receiver to provide a transmission path therebetween. The first cable extends through the hollow members of the first set: the second cable extends through the
10 hollow members of the second set. Thus changes in the optical signal in one or other path is utilised to provide an output signal.

The invention and its practice will be further described with reference to the accompanying drawings.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a portion of barrier structure embodying the invention, a part thereof being broken away to show the interior;

Figure 2 shows a block diagram of the fibre
20 optical monitoring system for the barrier of Figure 1;

Figure 3 shows in simplified diagrammatic form a number of such barrier structures joined together;

Figure 4 shows in diagrammatic form a portion of a barrier structure of Figure 1 having a modified
25 fibre optic monitoring arrangement; and

Figure 4a is an enlarged cross-section indicating the multi-strand nature of the fibre optic cable used in the arrangement of Figure 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

30 Referring to Figure 1, the barrier structure 10 is in the form of a rectangular panel having a rectangular frame 12 supporting a rectangular lattice structure 14 comprising horizontal (as shown in the figure) members 16 intersected by vertical members 18.

Each of the four sides of rectangular frame 12 is of a hollow box section and preferably each side is made of two overlapping U-shaped pieces bonded together. The box section has a sufficient wall thickness to
5 provide a frame of high rigidity. The sides are also suitably joined and bonded together. This manner of construction enables access to be gained during manufacture to what will become the interior of the box section which is entirely enclosed in the completed
10 panel. The horizontal members 16 are relatively large diameter tubes whose ends are received as a snug fit in respective apertures 20 in the vertical sides 12a of the frame so that the interior of each hollow member 16 communicates with the hollow interior of the frame. The
15 vertical members 18 are relatively small diameter tubes whose ends are received as a snug fit in respective apertures 22 in the horizontal sides 12b of the frame so that the interior of each hollow member 18 communicates with the hollow interior of the frame. The smaller cross-
20 section members 18 are in the same plane as and intersect the larger cross-section members 16. To this end each member 16 has spaced pairs of opposed apertures, such as 24, through which the vertical members pass with a snug fit at the apertures but without entirely blocking
25 the hollow interiors of the horizontal members. The horizontal and vertical members are bonded at the intersections.

The frame pieces and the tubular lattice members 16 and 18 are all made of glass-reinforced polyester.
30 All bonds between the frame pieces, the hollow lattice members and the frame sides, and between the horizontal and vertical members at the intersections are made with epoxy resin. The panel structure described can be made extremely strong - comparable to steel - but of much
35 lesser weight than an equivalent steel structure. The

resultant hollow interior is entirely sealed.

The basic structure thus far described incorporates a monitoring system for detecting breakage or severe distortion of the lattice upon an attempt to
5 force entry through the structure when installed. The system used is based on the transmission of light (e.g. in the visible or infra-red spectrum), through an optical fibre that is threaded through the hollow tubes of the lattice.

10 As illustrated in Figure 1, a detector unit 30 is contained within one side of the frame. In this case the unit 30 is a single package comprising a light transmitter 32 and a light receiver 34 which is optically coupled to the transmitter 32 by an optical
15 fibre 36 that is wound in a sinuous path through both the vertical and horizontal tubes constituting the lattice.. For example, the optical fibre may run in zig-zag fashion through the horizontal tubes and then be taken round a corner of the frame to run in like fashion
20 through the vertical tubes. At each bend in the zig-zag an arcuate pad such as shown at 38 is located in the frame on the inside of the bend to provide a smooth guide for the fibre. Sharp bends have to be avoided. A pad 39 can also be inserted at any corner round which the fibre
25 passes.

The optical fibre 36 and detector unit 30 are entirely contained within the hollow panel structure, whose interior is inaccessible, without damage to the structure. It will be noted that at each intersection
30 of the vertical and horizontal lattice members the optical fibre in the horizontal member can extend past the partial blockage caused by the vertical member. Because the monitoring system is entirely contained within the structure, it is inaccessible to tampering
35 and the risk of accidental damage is greatly reduced.

However, any attempt to break or cut the lattice

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structure so as to make an entry through it will result in breakage of the optical fibre and interruption of the light path. It is not necessary to actually break the fibre. A local distortion of the fibre as the
5 structure is attacked causes severe attenuation of the transmitted optical signal that is sensed by the receiver.

Figure 2 shows a block diagram of the monitoring system. The transmitter comprises a generator circuit
10 40 including a light-emitting diode (LED) 41 coupled to transmit light into one end of the fibre 36 through a coupler 42. This is a standard technique and need not be described in detail here. The receiver 34 comprises an input coupler 44 coupling the other end of the fibre
15 36 to an optical receiver 46 including a photo-diode 47 from which is obtained an electrical signal proportional to the received light. The signal is applied to an analyzer circuit comprising, for example, an adjustable threshold circuit 48 set to activate an output signal
20 generator 50 that provides an output alarm signal condition on line 49 when the amplitude of the received optical signal falls below a prescribed level. The receiver circuitry may employ standard techniques for the functions described and need not be explained in
25 greater detail. Other refinements can be added such as timing circuitry to exclude slow variations of signal level or brief interruptions of the signal that may occur in normal functioning. Such techniques are well known in the processing and analysis of signals
30 in many different sorts of intrusion detectors.

The sensitivity of the circuit so far described is limited by the signal-to-noise ratio at the receiver. As is known, sensitivity can be enhanced by modulating, that is chopping or pulsing, the optical signal and
35 selectively detecting the modulated signal. To this end

an oscillator 40a is associated with the generator 40 so that the LED 41 is pulse energised at a frequency determined by the oscillator. The receiver 46 detects the modulation and preferably employs the technique
5 known as synchronous demodulation in which it receives the oscillator frequency signal over line 46a and detects the received optical signal against the oscillator reference. All these techniques are well established.

The advantage of increasing the system
10 sensitivity is that higher attenuation can be tolerated in the fibre optic path and hence a cheaper, though more lossy, optical fibre can be employed.

The receiver and transmitter sections of detector unit 30 are both powered from an external low voltage
15 supply which is exterior to the barrier panel. The frame 12 is provided with some form of sealed receptacle or bushing 52 through which the external power supplies are taken and which also provides an outlet for a cable carrying the alarm signal to a remote monitoring point.
20 Provision can be made on the panel for local annunciation of the alarm.

Panels of the kind described can be made in various sizes and shapes dependent on their final usage. An installation barrier can be constructed from a
25 number of panels to have a required shape. Figure 3 diagrammatically illustrates four rectangular panels 121-124 forming a square structure. The contiguous sides of adjacent reinforced polyester panels are secured together by any suitable means to form a strong
30 integral structure. Each individual panel on the integrated structure is supplied with power from a single power supply source 126 as diagrammatically indicated by lines 127 to 130. The individual output alarm lines 132 to 135 from the panels are taken to a multiplexer

unit from which the multiplexed signals are sent to a remote station over line 136.

An alternative to the use of an optical fibre as an intrusion detector element is to thread a
5 conductor wire through the hollow panel structure and to monitor the continuity of the wire. However, this alternative is not considered to provide satisfactory protection. In particular a bridging loop can be connected across some or all of the conductor wire so
10 that the original wire can be cut without interrupting continuity. Such action is very much more difficult with an optical fibre. In addition a conductor wire does not exhibit an attenuation upon distortion of the wire such as is exhibited by an optical fibre when it is distorted
15 but not necessarily broken. Optical fibre technology is also known for its high immunity to interference when used in an electrically noisy environment..

It will be appreciated that the teachings of the invention can be applied to other forms of structure
20 in which a lattice or mesh type of barrier includes hollow members supported in and communicating with a hollow frame such that the optical fibre and the associated transmitter and receiver are entirely enclosed. In the above described embodiment, the optical fibre need
25 not be threaded through all the hollow members and the lattice could be constituted by a combination of hollow and solid members. The construction of the lattice could, of course, be done in ways other than described and other materials could be used, e.g. welded steel,
30 though at the cost of substantially greater weight.

While it may be convenient to have the optical transmitter and receiver in one package this is, of course, not essential. They may be separately disposed units.

35 The optical receiver described relies on detection

of amplitude changes in the optical signal. If the light transmitted by the optical fibre is monochromatic, as would be generated by using say a laser diode as the light source, distortion of the fibre produces phase as well as amplitude changes in the optical signal that can be detected at the receiver. The detection of phase change requires the provision of an optical reference at the receiver.

Another barrier structure that may be preferred for some uses is to have the vertical lattice members laid over and touching the horizontal members, i.e. the members in separate planes but contacting one another at the lattice intersections. In the case where glass-fibre polyester members are used the members are bonded at the contact points by spray bonding with an epoxy resin. This form of structure enables a single size tube to be used for both horizontal and vertical members and the tube may be of the small diameter. This gives a lighter structure than that illustrated though not so strong as obtained with the intersecting tubes. Again, the tubes open into the hollow box frame and are threaded with an optical fibre as described above.

A further modification is diagrammatically illustrated in Figure 4. This modification provides for two separate optical fibre paths. A hollow frame and mesh barrier structure 200 is formed as has been described with reference to Figure 1. The embodiment of Figure 4 differs in that a first optical fibre cable 210 extends in zig-zag fashion through the horizontal members 202 of the barrier and a second optical fibre cable 212 extends in zig-zag fashion through the vertical members 204 of the barrier. In addition the cable as illustrated in cross-section in Figure 4a is multi-strand with each strand providing a separate optical path. No sheathing of the bundle of strands is used. It is preferred that the number of strands be

not less than 10 and in a preferred arrangement a cable of 330 strands is used. A multi-strand fibre optic has a particular benefit discussed below.

Also shown in Figure 4 is the provision of
5 separate transmitter and receiver units 214 and 216 respectively. Unit 214 contains two independent optical transmitters 218 and 220 coupled to respective ends of the optical fibre cables 210 and 212. Each transmitter is in accord with the transmitter 32 of Figure 2.
10 Unit 216 contains two independent optical receivers 222 and 224 coupled to the other respective ends of the optical cables 210 and 212. The receiver end of cable 210 is shown as extending around the hollow frame 206 to reach the receiver 222. Each receiver is in
15 accord with the receiver of Figure 2 except that, if desired, both may activate a common alarm circuit 50. The transmitter and receiver units may be interconnected by electrical cable 214 to couple each receiver to its respective transmitter for synchronous detection. As
20 in Figure 1 all the fibre optics, transmitters and receivers are entirely contained and sealed in the barrier structure.

While even a single optical fibre is far more difficult to bridge than an electrical conductor, a
25 multi-strand fibre cable is still more difficult. Each fibre strand is transmitting independently a proportion of the total light and to bridge a section of the whole cable to establish an apparent optical continuity requires successfully bridging a significant proportion
30 of the strands; and, of course, the successfully bridging access to the multi-strand cable has to be made at two separate points. Thus a large number of strands reduces the prospects of successfully undermining the system.

35 The use of multi-strand fibre optics is, of course, applicable in the arrangement of Figure 1 using

the single optical path through both the vertical and horizontal members. Dividing the path into two separate paths as shown in Figure 4 has the advantage of reducing the path loss by half the number of dB, 5 assuming the two paths are about equal in length as compared to the single path. Thus the signal-to-noise at each receiver unit 214 and 216 is greatly improved, or put another way, cheaper, though more lossy, fibre optic can be employed for a given signal-to-noise ratio 10 at the receiver.

The panel of Figure 4 can be provided with a bushing 52 such as illustrated in Figure 1 for access of a power supply line to the panel and for egress of an alarm line or lines for multiplexing in the manner of 15 Figure 3. An alternative construction which is preferred for an installation comprising a large number of panels is to put the electronic circuitry of the receivers and transmitters into a separate sealed box such as indicated at 230 in dashed line. In this 20 case the internal transmitter and receiver units 218, 220 and 222, 224 respectively will contain only the light-emitting diodes and photo-diodes respectively. They are then connected by leads (not shown) extending through an aperture in frame 206 to the remaining circuitry in 25 sealed box 230 mounted at the outside of the frame. The link 226 is now contained within the unit 230. A multi-way cable 232 provides for the connecting of a sequence of units 230 to a common power supply and to a multiplexer for the alarm signal lines. The external box 230 and 30 cables 232 are provided with tamper detection as is well known in the security field.

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Claims

1. A barrier structure comprising a hollow frame; a mesh or lattice supported within and by the frame and comprising hollow members whose interiors communicate with the hollow of the frame, an optical fibre cable extending through at least some of the hollow members, a light source located in the hollow of the frame and coupled to one end of said fibre cable to transmit an optical signal along the fibre, and an optical receiver located in the hollow of the frame and coupled to the other end of said fibre cable to receive light therefrom, and including means responsive to changes in said optical signal to provide an output signal.
2. A barrier structure as claimed in Claim 1 in which said optical fibre cable is multi-strand.
3. A barrier structure as claimed in Claim 1 in which the mesh or lattice comprises a first set of parallel members and a second set of parallel members at an angle to the first set, and said optical fibre cable extends through members of both said sets.
4. A barrier structure as claimed in Claim 3 in which said optical fibre cable is multi-strand.

5. A barrier structure comprising a hollow frame; a mesh or lattice supported within and by the frame and comprising hollow members whose interiors communicate with the hollow of the frame, said members being constituted by a first set of parallel members and a second set of parallel members at an angle to the first set; first and second light sources located in the hollow of the frame; first and second optical receivers located in the hollow of the frame; a first optical fibre cable extending between said first light source and said first optical receiver to provide a transmission path therebetween, said first optical fibre cable extending through the hollow members of said first set; a second optical fibre cable extending between said second light source and said second optical receiver to provide a transmission path therebetween, said second optical fibre cable extending through the hollow members of said second set; and means responsive to a change in the optical signal received by said first or said second optical receiver to provide an output signal.

6. A barrier structure as claimed in Claim 5 in which said frame is of rectangular shape and said first and second sets of members are at right-angles to one another.

7. A barrier structure as claimed in Claim 5 in which said first and second optical fibre cables are each multi-strand.

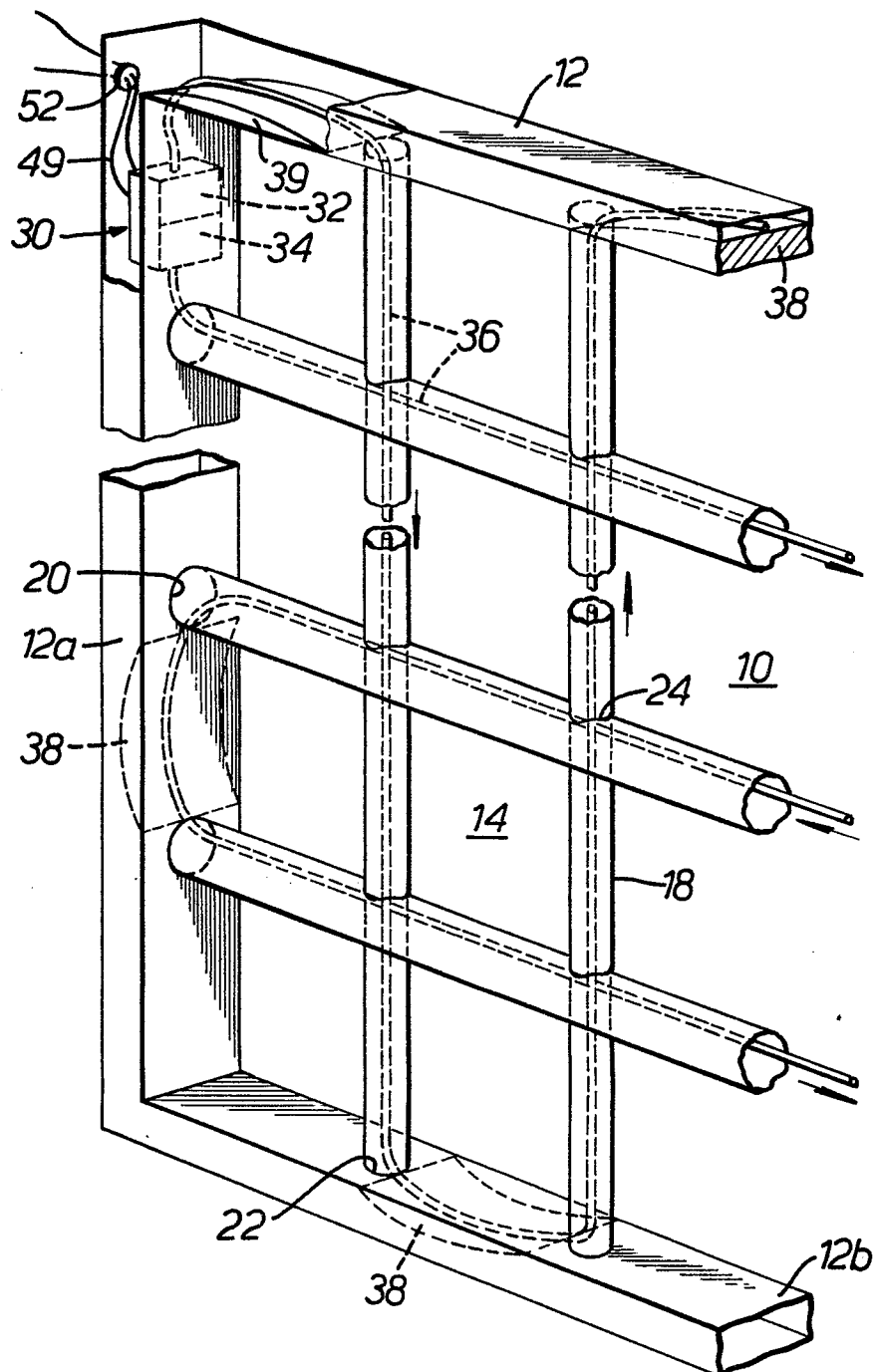


FIG. 1.

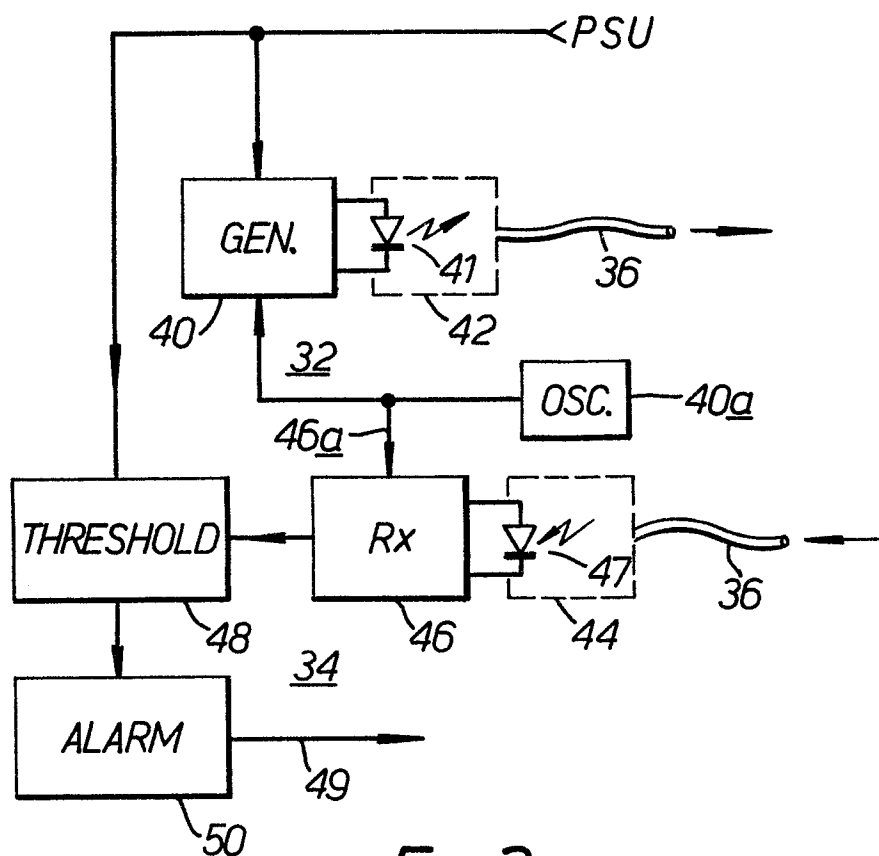


FIG. 2.

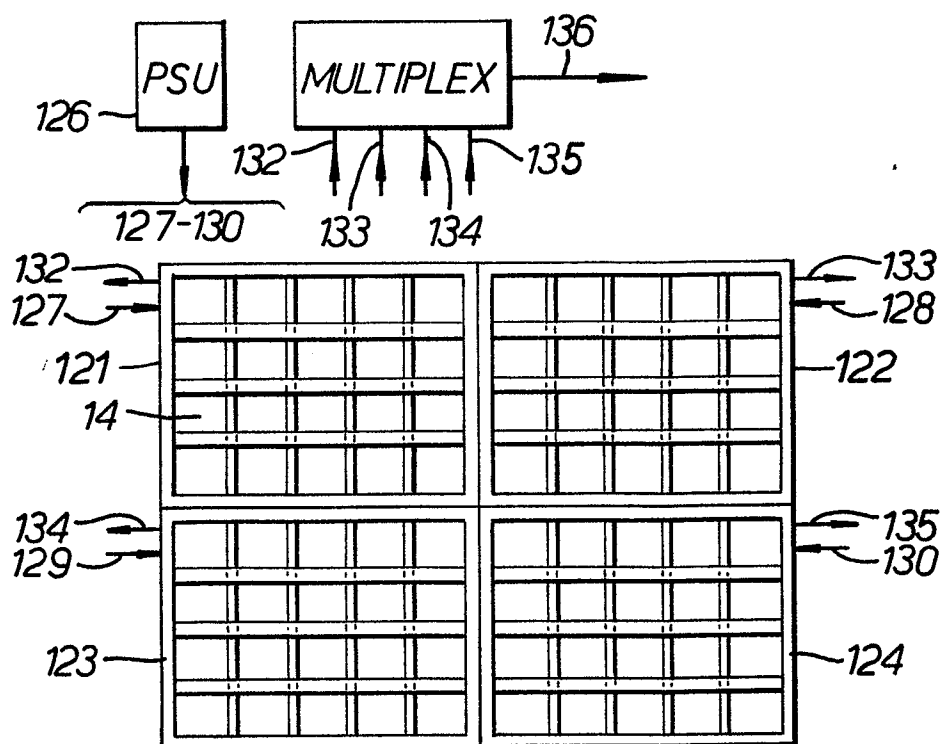


FIG. 3.

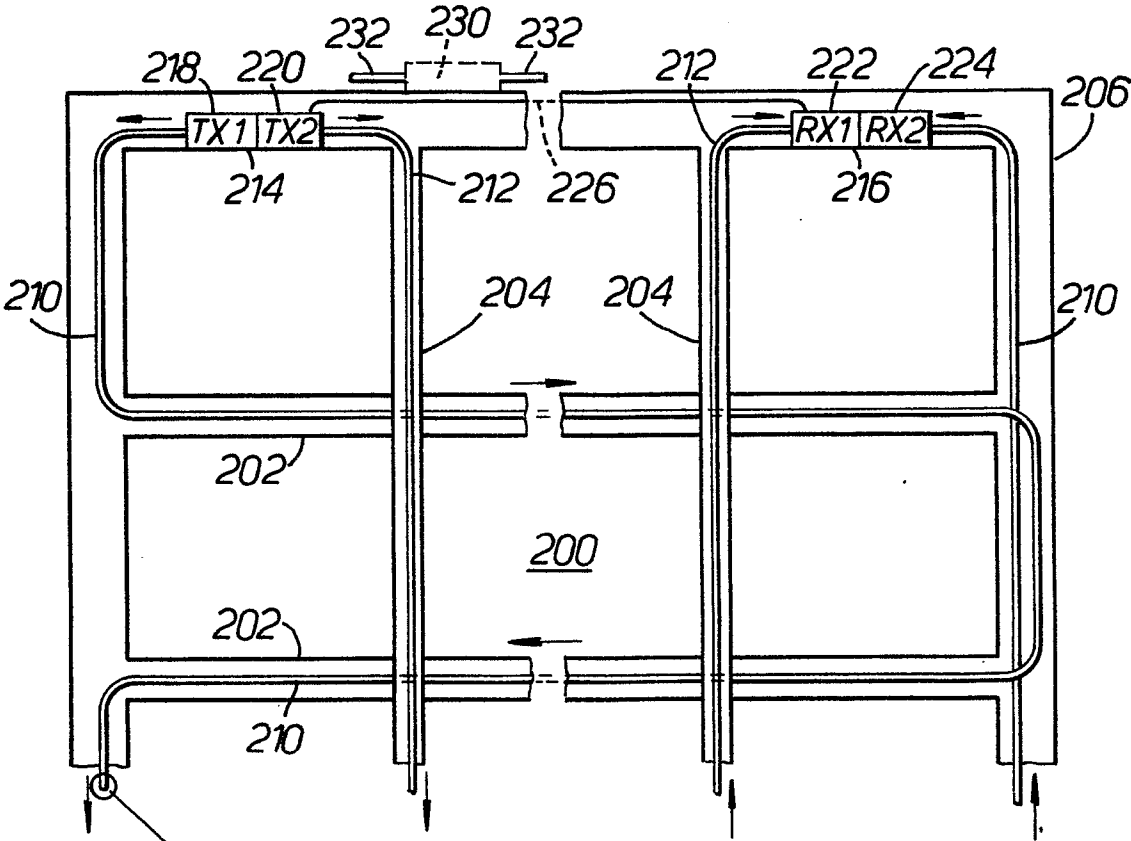


FIG. 4.



FIG. 4a.



European Patent
Office

EUROPEAN SEARCH REPORT

0072085
Application number

EP 82 30 1798.3

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
D,Y	GB - A - 2 053 544 (J.W. DAVEY) * whole document *	1,5	G 08 B 13/12 G 08 B 13/18
D,A	GB - A - 2 039 683 (FIBUN BV)		
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D,A	GB - A - 1 497 995 (STANDARD TELEPHONES AND CABLES LTD.)		TECHNICAL FIELDS SEARCHED (Int.Cl.3)
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A	CH - A5 - 539 309 (F. HÜGLI) * claim *	1,5	
Y	US - A - 4 090 902 (A. FERRENTINO et al.) * claims; fig. 3 *	3,7	
			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
X The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search Berlin		Date of completion of the search 18-08-1982	Examiner BEYER