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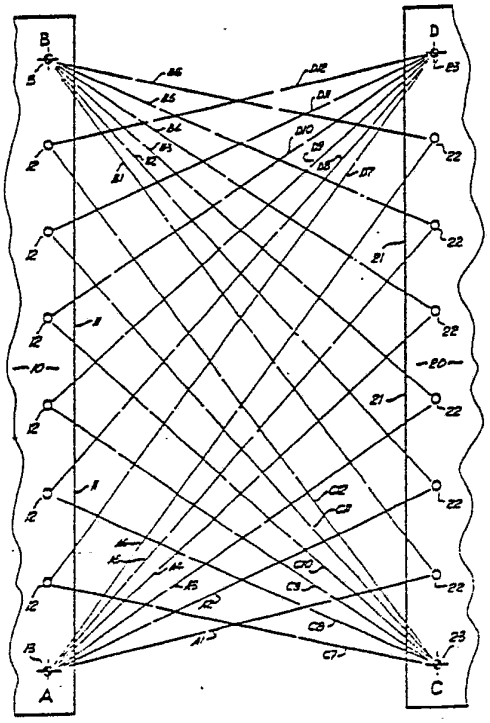
(54) Title: PHOTOELECTRIC OBSTRUCTION DETECTOR FOR ELEVATOR DOORWAYS

(57) Abstract

In the entranceway between an elevator car and a floor are two oppositely sliding doors (10, 20). The approach of these doors is controlled by a detection system that senses the presence of objects between the doors. This system includes, on each door, a plurality of emitters (12, 22) which are vertically spaced apart the door edge (11, 21), for radiating non-collimated light towards the edge of the other door. At the top and bottom portions of each door edge there is a sensor (13, 23), which can receive the radiation for the emitters on the other door edge. The emitters on each door edge are sequentially turned on and the sensors on the opposite door edge provide a corresponding signal as they are turned on, unless an obstruction is in the way, causing the detection system to generate a signal that thus indicates that an objet is between the doors.



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Description

PHOTOELECTRIC OBSTRUCTION DETECTER FOR ELEVATOR DOORWAYS

Technical Field

This invention relates to equipment for sensing that an object is in a defined space, in particular, a doorway, such as an elevator car doorway.

Background Art

In elevators it is common to use one or more sliding doors and to open and close them automatically. Consequently, often equipment is used that detects the presence of an obstructing body, namely a passenger, between the doors just prior to and during their automatic closure to control equipment to prevent the doors from closing more and, preferably, reopen them.

One such device puts a light beam in a path transverse the door opening and uses a sensor to detect an interruption of the light beam, which would occur if an obstruction is between the door. Then, upon sensing an interruption, the sensor issues a signal to the door control mechanism to alter the normal operation of the doors, preferably reopen them.

In usual practice that device has an array of light sources disposed on one side of the doorway, producing parallel light beams at different levels, and a corresponding array of photo-sensitive detectors arranged on the other door, for sensing those light

beams, thus creating a system which can sense objects of different heights between the door. For maximum sensitivity, the light beams are generally collimated by a lens to ensure that each sensor is responsive to one light source.

This arrangement, although generally satisfactory, has a disadvantage: because the light beams are spaced apart from each other, objects between the beams are not sensed. For instance, an arm extended horizontally may fail to be sensed.

The sensitivity could, of course, be improved, for instance, by spacing the parallel beams more closely together, in effect, providing substantially contiguous light beams. But, that would be costly to implement, and, to maintain sensitivity, the light beams would need to be highly collimated to prevent stray light from one sensor from reaching an adjacent - the wrong - sensor, as that could blind the sensor. The large number of photodetectors and their optical systems for beam collimation that would be needed would, of course, add significantly to cost. Mirrors may be used to extend the path length of a light beam from its source so that the beam traverses the door opening a number of times prior to striking a photodetector. But, while that reduces the number of detectors required, it also reduces the intensity of the light beam reaching each detector; thus, in the end, increasing the demands on beam optics.

Consequently, the simple array of spaced apart parallel beams has been widely accepted as being the best compromise of safety, efficiency and cost.

Disclosure of Invention

According to the present invention, a device for sensing the presence of an object in the doorway of an elevator cab comprises: a plurality of emitters, each spaced apart from each other, and each activatable to emit radiation; a plurality of sensors each adapted to issue a signal in response to radiation received from an emitter, said sensors each being spaced apart from each other, and each being spaced apart from each emitter along a radiation path extending between it and that emitter; means for activating said emitters repetitively in a first sequence; and means for detection of a signal, if any, issued by any one of said sensors in response to an activated emitter; whereby an obstruction occurs during said sequence of any radiation path extending between any one of said emitters and one of said sensors may be detected.

Brief Description of Drawings

Fig. 1 is a schematic diagram showing an arrangement of emitters and sensors disposed, according to the invention, on adjacent cooperating elevator doors.

Fig. 2 shows the arrangement of Fig. 1 as the doors approach each other.

Figs. 3, 4 and 5 show other arrangements of sensors and emitters according to the invention.

Best Mode for Carrying Out the Invention

In Figs. 1 and 2 there is a first elevator door 10 and a second elevator door 20. These doors, shown in an open position in Fig. 1, slide to open and close, and, as they close, the closure edge 11 of door 10 touches the closure edge 21 of door 20.

A plurality of elements, made up of emitters 12 and 22 and sensors 13 and 23, define a first "array" and a second "array" on the closure edges 11, 21.

The first array is comprised of the emitters 12 that are spaced apart from each other along the edge 11 and the sensors 13 that are at the top and bottom of the edge 11.

The second array, on the adjacent closure edge 21 (on door 20) is comprised of the remaining emitters 22 and sensors 23, which are on the edge 21.

The emitters may be light bulbs, LED devices or any radiation emitting device; for example, an infrared emitter that is modulated, so that its emitted radiation is distinguishable from background radiation of the surroundings.

Likewise, the sensors may be any device that is sensitive to the radiation of the emitters; yet, adapted to be insensitive to radiation other than from the emitters. Thus, the sensors may be photodiodes, phototransistors or the like, and these may be gated in synchronization with a modulated emitter for improved sensitivity.

The radiation from the emitters is not collimated, unlike related prior techniques that use lights and detectors in matched pairs, where

collimation is required for good sensitivity. Consequently, each sensor actually receives radiation in a plurality of paths, each extending between the sensor and one of the emitters, as Fig. 1 shows.

In Figs. 1 and 2, the plurality of radiation paths that extend between emitters and sensors are shown; each path is distinguished there by an alphabetic index that is indicative of the sensor, and a numeral that is indicative of the emitter at the ends of the path. From Fig. 2 it is apparent that these paths criss-cross, defining a network in space, the gap between the door closure edges 11 and 21, and that the space between these paths is smaller than in the prior art devices.

A circuit is provided whereby each emitter is energized to emit radiation in a first sequence, and each sensor is monitored in a second sequence so that one emitter is energized and one sensor is monitored, at any time. For example, each of the emitters 12 is energized in sequence while one of sensors 23 is monitored; then each of emitters 22 is energized sequentially while one of sensors 13 is monitored. After that, each of emitters 12 are again sequentially energized while the other (the second of the sensors 23) is monitored. Then the emitters of sensors 22 are again sequentially energized while the other (the second sensor 13) is monitored. The exact sequence is not important, although, in a preferred, basic operation, each emitter and a sensor combination that define a radiation path therebetween is respectively energized and monitored repetitively many times per second in some sequence.

Each path is thus monitored for obstruction once in an overall sequence, and, because the sensor does not receive radiation from other emitters and no other emitter is activated, the sensor is highly sensitive to the obstruction. For maximum sensitivity, the sensitivity of the sensors may be adjusted in synchronization with the energization of the emitters, since each path involves a unique combination of sensor and emitter. For example, the gain of an amplifier receiving a signal from sensor 13 may be higher when one emitter 22 is activating path C7 than when another emitter 22 is activating path A6.

With reference to Fig. 2, it shows the embodiment of Fig. 1, but when the doors are in a more nearly closed position, it will be seen there that the flux density in space of the radiation paths increases as the doors approach each other.

In its simplest form, the invention includes embodiments such as those shown in Figs. 3, 4 and 5. Yet, those skilled in the art will recognize that because emitters are available at low cost in comparison with sensors, there are many possible geometric arrangements within the scope of the invention.

It is desirable, to produce a signal, that only one combination of sensor and emitter are active at any time; but, a combination of sensors and emitters may also be selected for simultaneous activity. For example, at the same time that an emitter on one edge and a sensor on the other edge are operative, a sensor on that one edge and an emitter on that other edge may be operative.

The circuits required to construct embodiments according to the invention may use multiplex techniques which are apparent to those skilled in the art from the foregoing. Also, embodiments of the invention may be utilized in a somewhat different application, not to monitor the doorway entrance to an elevator, but as a security device to monitor an area; for example, to sense when someone is in a dangerous position with relation to a machine, or to sense the movement of people on and off properly, or, for that matter, to sense the presence of an object in any predetermined space.

Other modifications to the embodiment of the invention that have been described will be obvious to those skilled in the art, yet within the scope of the invention.

Claims

1. Apparatus for detecting an object in a passageway, characterized by:

a plurality of radiation emitters spaced along at least one edge of the passageway, each emitter being activatable to emit radiation;

at least one radiation sensor or receiver on the edge of the passageway opposite said one edge for providing an output signal in response to radiation from each emitter;

first means for activating each emitter in a selected sequence;

second means for providing a detection signal which manifests that object in the path between that said particular emitter and each sensor in response to the operation of said first means to activate a particular emitter and the absence of the output signal from one or more of said sensors.

2. Apparatus according to claim 1, characterized by:

two sensors on said opposite edge of the passageway; and

said second means comprising means for providing said detection signal in response to the activation of a particular emitter and the absence of an output signal from one of said two sensors.

3. Apparatus according to claim 1, characterized by:

said emitters being spaced along both edges of the passageway;

two or more of said sensors being on each edge of the passageway;

said second means comprising means for providing said detection signal in response to the activation of a selected emitter on one edge of the passageway and, in a selected sequence, the absence of an output signal from each of the two sensors on the opposite edge of the passage.

4. An apparatus according to claim 3, characterized in that:

on each edge there is a first sensor at the upper portion and a second sensor at lower portions of the edge and a plurality of emitters between said first and second sensors.

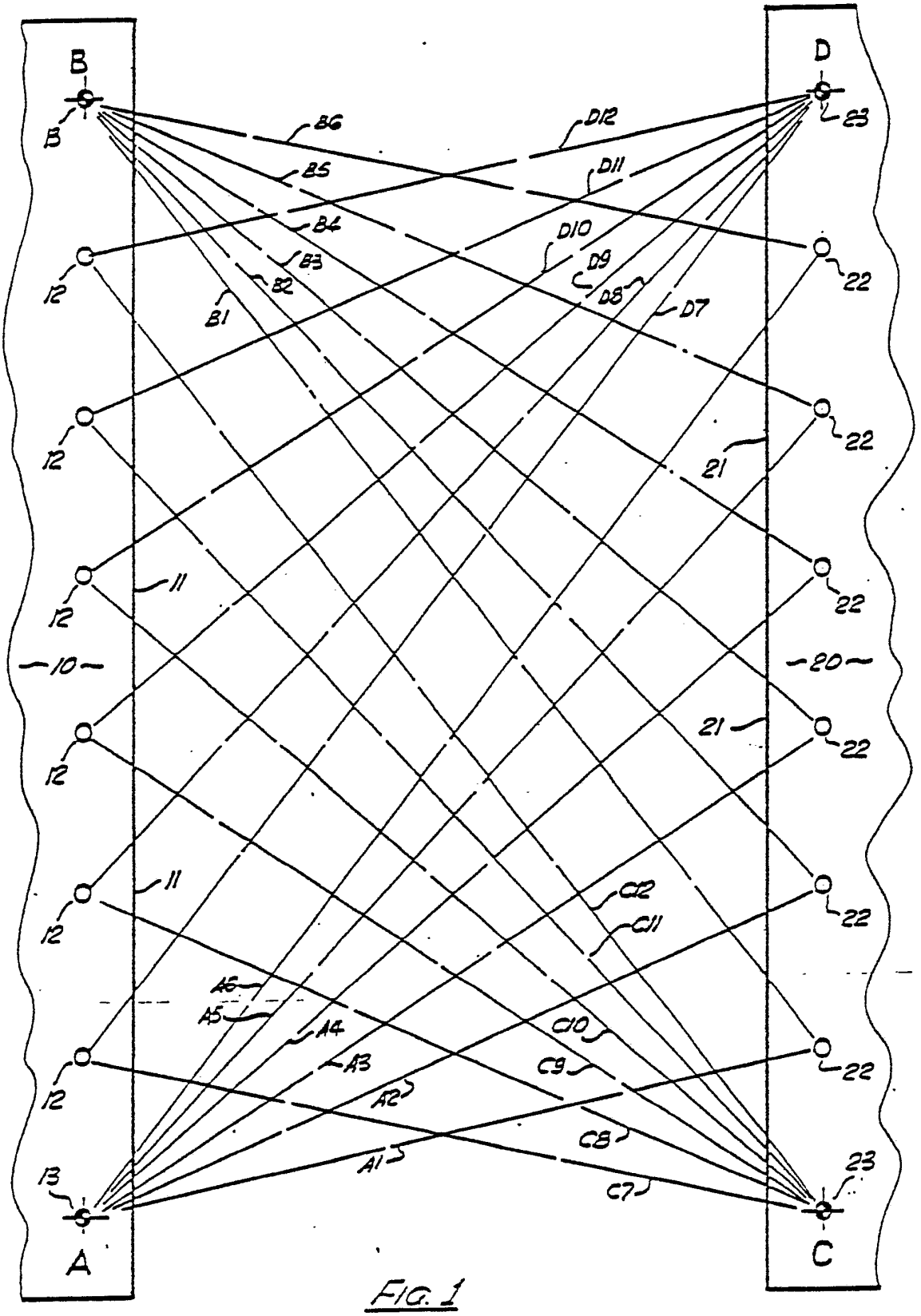

FIG. 1

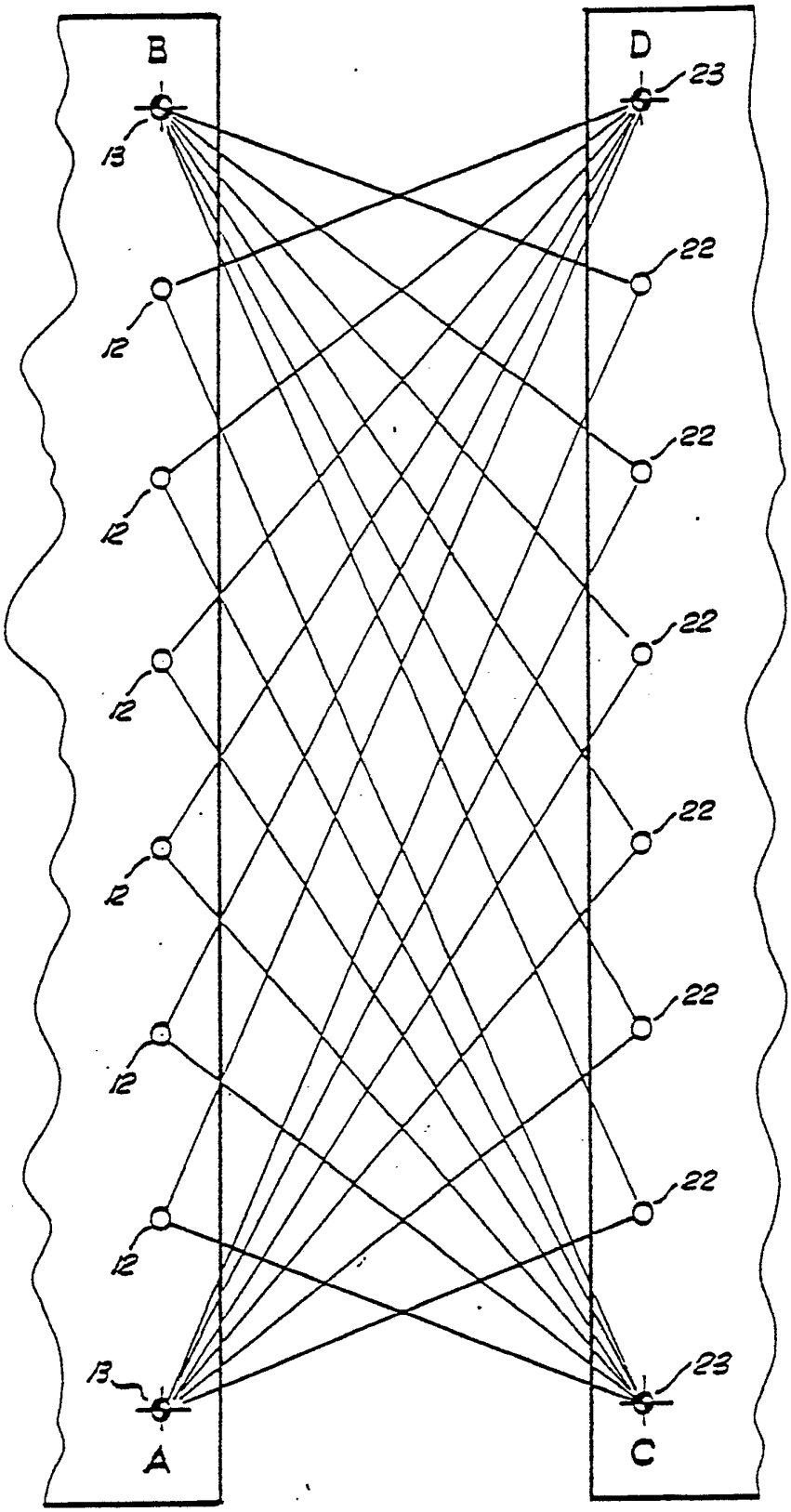

FIG. 2

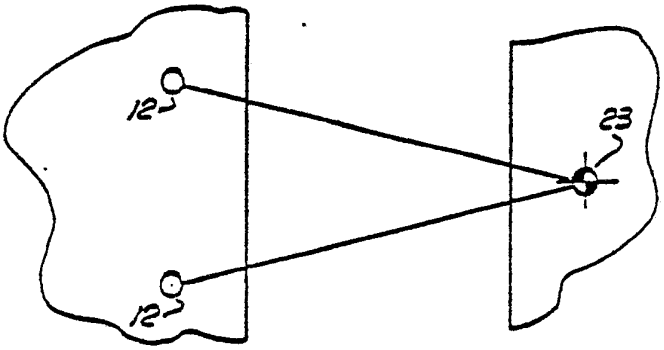

FIG. 3

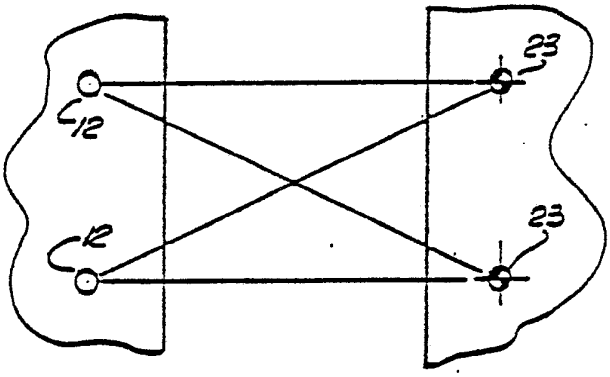

FIG. 4

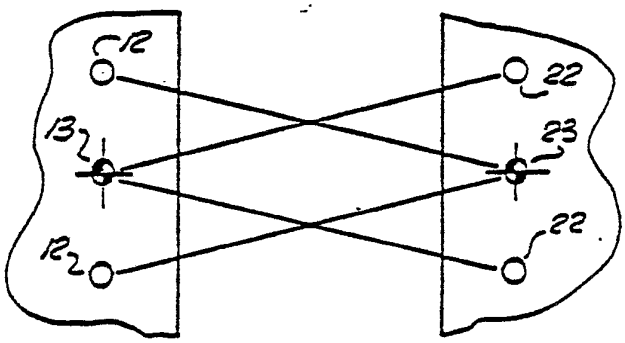

FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/US82/00113

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.[3] G 08 B 13/18
U.S. CL. 340/555;250/221

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	340/19R,555,556,557;250/221

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 2,900,521, Published 18 August, 1959, Eames	1-4
A	US, A, 3,183,499, Published 11 May 1965, Cowen	1-4
A	US, A, 3,235,738, Published 15 February 1966, Kress et al	1-4
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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
16 April 1982	04 MAY 1982
International Searching Authority [1]	Signature of Authorized Officer [20]
ISA/US	David L. Trafton