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Amended claims in accordance with Rule 86 (2) EPC.

(54) System and method for detecting and managing occupation of an area by objects

(57) Described herein is a system (1) for detecting and managing occupation of an area (3) by objects (2), said system comprising: a plurality of sensor devices (4), which are arranged in a plurality of points (A) within the area (3) in order to detect a state of occupation or a state of non-occupation of each point (A) by at least one object (2) located within the area (3); and a processing unit (5) designed to determine, as a function of the state detected in the points (A) by the sensor devices (4), the degree of non-occupied free surface that is available within the area (3) in order to accommodate at least one further object (2).

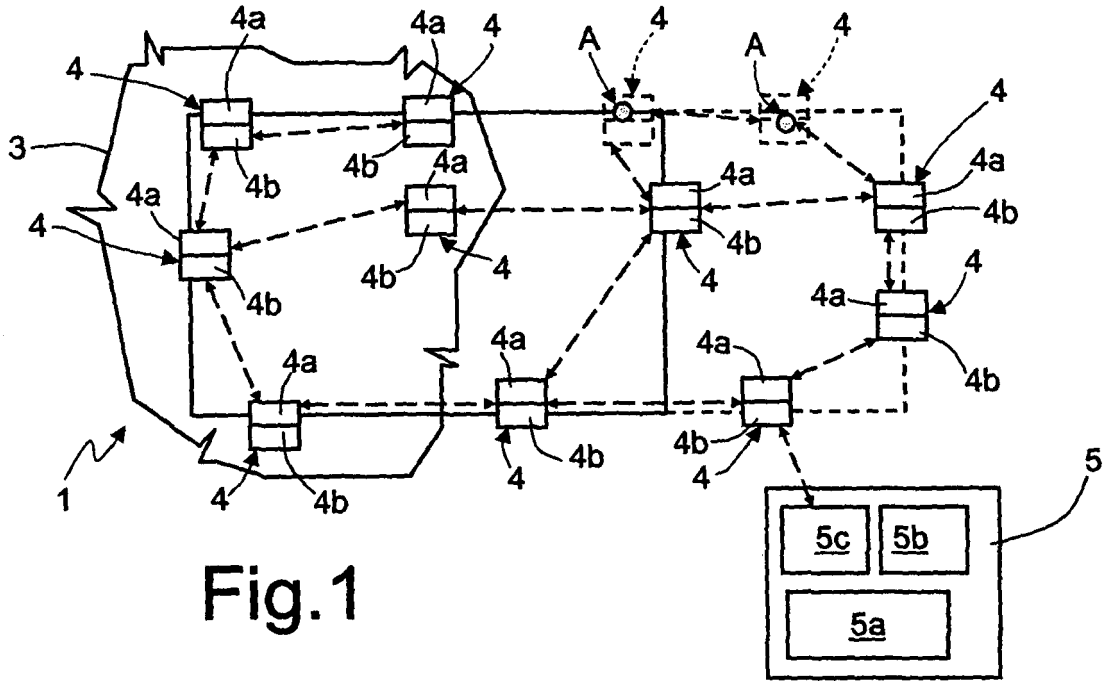

Fig.1

EP 1 816 623 A1

Description

[0001] The present invention relates to a system and a method for detecting and managing occupation of an area by objects.

[0002] In particular, the present invention regards a system and a method designed to detect and manage occupation of an area dedicated to parking of means of transport, such as, for example, bicycles, motor cycles, automobiles, campers, vans, lorries, and buses, to which the ensuing treatment will make explicit reference without this implying any loss of generality.

[0003] As is known, the detection of occupation of parking or waiting areas by means of transport and in particular management of the free spaces present within said areas today represents one of the main questions that form the subject of continuous interventions and improvements aimed at obtaining an optimization of the public or private spaces that can be occupied by means of transport when parking, the latter being a requirement that is particularly felt both by users of the means of transport and by the various attendants or bodies responsible for management and control of the areas got the parking or waiting of vehicles.

[0004] For this purpose, systems have been proposed provided with image-acquisition apparatuses based upon infrared technology, which detect the image of a delimited area in order to verify the state of occupation thereof by means of transport. In detail, said areas are designated by the term "delimited areas" in so far as they are typically circumscribed by lines drawn on the surface of the parking area which mark off the space reserved to parking of a means of transport of given dimensions.

[0005] The infrared detection systems referred to above present the major drawback of being far from reliable in so far as image acquisition is affected by the external environmental lighting conditions. In particular, in the presence of poor lighting present, for example, at night or in the case of rain or fog, the system becomes particularly subject to disturbance and far from reliable.

[0006] The aim of the present invention is hence to provide a system that will overcome the drawbacks described above and that will contribute to improving and optimizing management of occupation of an area by objects, which correspond, in particular, to means of transport.

[0007] The above aim is achieved by the present invention in so far as it regards a system designed to detect and manage occupation of an area by objects, according to what is specified in Claim 1 and, preferably, in any one of the subsequent claims depending either directly or indirectly upon Claim 1.

[0008] According to the present invention, a method is moreover provided, designed to detect and manage occupation of an area by an object, according to what is specified in Claim 9 and, preferably, in any one of the subsequent claims depending either directly or indirectly upon Claim 9.

[0009] The present invention will now be described with reference to the annexed plate of drawings, which illustrate a non-limiting example of embodiment thereof, and in which:

- Figure 1 is a schematic illustration of a system for detection and management of an area that can be occupied by objects, said system being provided according to the teachings of the present invention;
- Figure 2 represents a system for detection and management of a parking area occupied by means of transport, said system being provided according to the teachings of the present invention;
- Figure 3 is a schematic illustration of an example of a possible first arrangement of means of transport within a delimited parking area; whilst
- Figure 4 is a schematic illustration of an example of a possible second arrangement of means of transport within a delimited parking area.

[0010] The present invention is essentially based upon the principle of detecting in a plurality of points distributed within an area, a state of occupation or a state of non-occupation of each point by at least one object located in the area itself, and of determining, as a function of the state detected in the points, the degree of non-occupied free surface that is available within the area in order to place at least one further object.

[0011] In other words, the present invention is essentially based upon the idea of determining, through an array or grid of sensor devices appropriately distributed on an area to be managed, a set of information regarding the dimensions of the surface occupied within the area itself by one or more objects, and of processing said information to calculate the degree of free space present in the area itself, which can potentially be occupied by further objects.

[0012] With reference to Figures 1 and 2, the reference number 1 designates as a whole a system that is able to determine the extension of area 3 occupied by one or more objects 2 in order to calculate, as a function of said extension, the degree of non-occupation of the area 3, i.e., the ratio or amount of free surface that can be occupied by other objects 2 within the area 3 itself.

[0013] In particular, the system 1 is able to determine the dimensions of the free surface that can be occupied, verify whether the free surface determined within the area 3 can be occupied or otherwise by one or more objects 2, and identify, on the basis of the verification made, the type of object or objects that can be located on the free surface identified.

[0014] The system 1 basically comprises a plurality of sensor devices 4, which are arranged in a set of points A of the area 3 according to a pre-set plane geometrical configuration and are each designed to supply an indication regarding the state of occupation or of non-occupation of the corresponding point A of the area 3 by an object 2.

[0015] In particular, in the example shown in Figures 1 and 2, the points A, on which the sensor devices 4 are arranged, are distributed over the surface of the area 3 according to a matrix or grid-like geometrical configuration, in which each point A is associated uniquely to a given row and column. In the case in point in Figure 1, the points A belonging to one and the same row or to one and the same column are arranged so that they are not aligned with respect to one another, but it is evident that they can also be arranged along a row or a column so that they are aligned with respect to one another (Figure 2).

[0016] The system 1 further comprises a processing unit 5, which is designed to receive from the sensor devices 4 the information regarding the state of occupation or non-occupation of the respective points A and is designed to process said information to identify the free points A (i.e., the points not occupied by any object) so as to be able to verify, as a function of the latter, the presence/absence of free surfaces that can be occupied, and the amount or ratio thereof that can be occupied.

[0017] With reference to Figure 1, the sensor devices 4 each comprise: a detection sensor 4a, which supplies a detection signal containing the information regarding occupation or non-occupation of the point A; and a communication module 4b, which is able to communicate the detection signal to any other sensor device 4 and/or directly to the processing unit 5.

[0018] In particular, the detection sensor 4a can comprise, for example, an infrared sensor or an ultrasound sensor, or any other type of sensor of the sort. In the case in point, in the example illustrated in Figure 1, each detection sensor 4a is stably fixed in a known way on the plane surface of the area 3 in a position corresponding to the point A so as to generate the detection signal indicating the occupation of the point A when an object 2 or a portion of object 2 is above the detection sensor 4a itself.

[0019] As regards, instead, the communication module 4b of the sensor device 4, this has the function of communicating with any of the other sensor devices 4 and/or directly with the processing unit 5 so as to transmit to the latter the corresponding detection signal.

[0020] In the example illustrated in Figure 1, the communication modules 4b are advantageously able to implement a wireless communication with the processing unit 5 so as to transmit the detection signals thereto. The wireless communication can be obtained, for example, advantageously by implementing the communication protocol ZigBee or any other similar protocol.

[0021] In particular, each communication module 4b is able to communicate with the processing unit 5 through a "short range" transceiving sequence made between a set of communication modules 4b of the sensor devices 4 arranged between the communication module 4b itself and the processing unit 5.

[0022] According to a different embodiment (not illustrated), each communication module 4b is able to make a short-range communication with the processing unit 5.

[0023] As regards the processing unit 5, this may be defined by a local computer, which is designed to receive the detection signals generated by the array of sensor devices 4 and process them according to an algorithm, which determines, as a function of the position of the occupied points A within the area 3, the size of the surface occupied by the objects 2, and the size of the free surface that can be occupied.

[0024] The processing unit 5 is able to determine, as a function of the free surface that can be occupied, the size and hence the type and number of objects that could potentially be arranged in the free surface that can be occupied.

[0025] In particular, the processing unit 5 is provided with a computing module 5a, and a storage module 5b, stored in which are: a first table containing, for each point A, to which a sensor device 4 is associated, the respective co-ordinates measured according to a given geometrical reference system; and a second table containing a set of types of objects and for each type of object the corresponding dimensions of surface occupation and/or the degree of surface occupation within an area.

[0026] The processing unit 5 further comprises a module 5c that is able to implement a long-range or short-range communication with the sensor devices 4.

[0027] In use, the sensor devices 4 transmit, at preset time intervals, the detection signals to the processing unit 5, which calculates, as a function of the condition of occupation and of non-occupation of the points A and of their positions (which can be calculated through the first table), the dimensions of the surface occupied, and the degree of free surface present in the area 3.

[0028] Once the degree of free surface with respect to the area 3 has been determined, and in particular the size of the free surface itself, the computing module 5a identifies through the second table and as a function of the values calculated (ratio of free surface and/or size thereof), the type and/or combination of the objects having dimensions such that they can be accommodated in the free surface itself.

[0029] Furthermore, the system 1 is designed to receive a request for positioning of a new object 2 in the area 3 and is able to verify whether there exists or not enough free space in order to position the object 2 itself. In particular, in the case where a sufficient free space exists, the processing unit 5 identifies the position of the free space within the area 3 in which the object 2 can be positioned.

[0030] In the case in point, the processing unit 5 is designed to: receive at input information that encodes the type and/or dimensions of the new object 2 to be positioned in the area 3; verify, on the basis of the conditions of occupation of the points A, the free space that can be occupied and hence the type of objects 2 that can be arranged in the free space itself; check whether the new object 2 can be positioned or otherwise in the free space; and determine preferably, but not necessarily, the

optimal position of insertion.

[0031] The system 1 may be able to recognize in a completely automatic way the type and hence the dimensions of the object 2 that must be set in the area 3. In particular, the system 1 can be provided with a recognition area 10 (Figure 2) in which the object 2 to be recognized is set.

[0032] In the example shown in Figure 2, the system 1 is provided with a plurality of detection sensor devices 11 equivalent to the detection sensor devices 4 described above (some of which are represented in Figure 2 with a dashed line), which are arranged in the recognition area 10 in respective points B and are each designed for supplying to the processing unit 5 a detection signal indicating the occupation or non-occupation of the point B by the object 2 to be recognized.

[0033] In use, the object 2 to be recognized is set in the recognition area 10, and the processing unit 5, having received the detection signals generated by the detection sensor devices 11, determines the surface of the recognition area occupied by the object 2 as a function of the state of occupation or non-occupation detected by the sensor devices 11 in the respective points B.

[0034] Following upon determination of the surface of the recognition area 10 covered by the object 2, the processing unit 5 is able to determine the type and/or dimensions of the object 2.

[0035] The system 1 can find advantageous application in detection and management of the surface that can be occupied in the areas 3 dedicated to parking or waiting of means of transport, such as, for example, bicycles, motor cycles, automobiles, campers, vans, lorries, buses.

[0036] Figure 2 shows an application of the system 1, in which the parking area 3 is occupied (in sequence from left to right in Figure 2) by a bicycle 12, an automobile 13, a van 14, and a lorry 15, and in which the recognition area 10 is set in a position corresponding to the entrance I to the parking area 3 in such a way as to enable the processing unit 5 to recognize automatically the means of transport prior to its entry into the parking area 3, and verify, on the basis of said recognition and as a function of the free space detected within the parking area 3, whether said means of transport can be accommodated within the parking area 3 itself.

[0037] With reference to the example illustrated in Figure 2, the processing unit 5 processes the detection signals generated by the sensor devices 4 and identifies in the area 3 the presence of a bicycle 12, an automobile 13, a van 14, and a lorry 15, and calculates the size of the free space that can be occupied by other means of transport.

[0038] Following upon determination of the free space, according to the dimensions of the vehicle recognized, which in the example illustrated corresponds to a bicycle 12, a combination of the sub-areas S (indicated with dashed line in Figure 2) that can be occupied by the bicycle 12 is identified within the free space that can be occupied.

[0039] In the above description, it should be pointed out that the parking area 3 can correspond to a non-delimited area or else to an area delimited in a pre-set way by means of the visible lines L (traced on the surface of the area), sized for containing a given means of transport. In the example shown in Figures 3 and 4, the system 1 is able to verify whether within the delimited area 3 there exists a portion of space sufficient for accommodation of another means of transport. For example, in the case where the delimited area 3 is sized in such a way as to be able to contain a lorry 15 (Figures 3 and 4), and is occupied by an automobile 13 (indicated by the solid line), the system 1 detects the existence of a free space sufficient to accommodate another automobile 13 (represented with a dashed line in the configuration appearing in Figure 3) or alternatively a pair of bicycles 12 (represented with a dashed line in the configuration appearing in Figure 4).

[0040] The system 1 described above is extremely advantageous in so far as it enables optimal management of the spaces available within an area in which the objects can be positioned.

[0041] In addition, the system is particularly advantageous in so far as, unlike systems of an infrared type, it is not subject to disturbance by any variation in the environmental lighting conditions that occur in case of poor night lighting, or in the presence of rain, fog, etc.

[0042] Finally, it is clear that modifications and variations can be made to the system 1 described and illustrated herein without thereby departing from the scope of the present invention, defined in the annexed claims.

Claims

1. A system (1) for detecting and managing occupation of an area (3) by objects (2); the system being **characterized in that** it comprises:

   - sensor means (4) arranged in a plurality of points (A) within the area (3) for detecting a state of occupation or a state of non-occupation of each of said point (A) by at least one object (2) accommodated in the area (3) itself; and
   - processing means (5) designed to determine, as a function of the state detected in the points (A) by said sensor means (4), the degree of non-occupied free surface that is available within said area (3) in order to accommodate at least one further object (2).

2. The system according to Claim 1, **characterized in that** said processing means (5) comprise computing means (5a) designed to determine, as a function of the state detected by said sensor means (4) in the points (A), the size of the non-occupied free surface that is available within said area (3) in order to ac-

commodated at least one further object (2).

3. The system according to Claim 2, **characterized in that** said computing means (5a) are designed to determine, as a function of said size of the non-occupied free surface, the type of objects (2) that can be arranged within the non-occupied free surface.

4. The system according to Claim 2 or Claim 3, **characterized in that** said computing means (5a) are designed to determine, as a function of the size of the non-occupied free surface, a combination of different types of objects (2), which can be arranged within the non-occupied free surface itself.

5. The system according to any one of Claims 2 to 4, **characterized in that** said computing means (5a) are designed to receive information indicating the type of object to be positioned within said area (3), and to verify, as a function of the free surface determined, whether said object can be set within said area (3).

6. The system according to any one of the preceding claims, **characterized in that** said sensor means (4) are located in a plurality of points (A) of the plane surface of said area (3) according to a substantially matrix geometrical distribution.

7. The system according to any one of the preceding claims, **characterized in that** said area (3) comprises a parking area, and said objects (2) comprise means of transport.

8. The system according to Claim 7, **characterized in that** it comprises a plurality of sensor means (11) arranged in a plurality of points (B) of a recognition area (10) according to a pre-set geometrical configuration for detecting a state of occupation or a state of non-occupation of each of said point (B) by a means of transport located in the recognition area (10) itself; said processing means (5) being designed to determine, as a function of the state detected in said points (B) by said sensor means (4), the type and/or the dimensions of said means of transport.

9. A method for detecting and managing occupation of an area (3) by objects (2); said method being **characterized in that** it comprises the steps of:

- detecting in a plurality of points (A) distributed within the area (3) a state of occupation or a state of non-occupation of each point (A) by at least one object (2) located in the area (3) itself; and
- determining, as a function of the state detected in said points (A), the degree of non-occupied free surface that is available within said area (3) in order to accommodate at least one further object (2).

10. The method according to Claim 9, **characterized in that** it comprises the step of determining, as a function of the state of occupation or non-occupation detected in said points (A), the size of the non-occupied free surface that is present within the area (3) in order to accommodate at least one further object.

11. The method according to Claim 10, **characterized in that** it comprises the step of determining, as a function of the size of the non-occupied free surface, the type of objects (2) that can be arranged within said non-occupied free surface.

12. The method according to Claim 10 or Claim 11, **characterized in that** it comprises the step of determining, as a function of the size of the non-occupied free surface, a combination of the types of objects that can be arranged within the non-occupied free surface itself.

13. The method according to any one of Claims 9 to 12, **characterized in that** it comprises the steps of:

- detecting in a plurality of points (B) distributed inside a recognition area (10), a state of occupation or a state of non-occupation of each point (B) by at least one object (2) set in the recognition area (10) itself;
- determining, as a function of the state of occupation or non-occupation detected in said points (B) of the recognition area (10), the type and/or the dimensions of said object (2); and
- verifying, as a function of the type and/or of the dimensions of said recognized object (2) and on the basis of the dimensions of the free surface determined, whether it is possible or not to accommodate said object (2) in said free surface determined.

14. The method according to any one of Claims 9 to 13, **characterized in that** said area (3) comprises a parking area, and said objects (2) comprise means of transport.

Amended claims in accordance with Rule 86(2) EPC.

1. A system (1) for detecting and managing occupation of an area (3) by objects (2); the system being **characterized in that** it comprises:

sensor means (4) arranged in a plurality of points (A) within the area (3) for detecting a state of occupation or a state of non-occupation of each of said point (A) by at least one object (2) ac-

commodated in the area (3) itself; said sensor means (4) being stably fixed on the plane surface of the area (3) in a position corresponding to the point (A) so as to generate the detection signal indicating the occupation of the point (A) when an object (2) or a portion of object (2) is above the sensor means 4a itself; and

- processing means (5) designed to determine, as a function of the state detected in the points (A) by said sensor means (4), the degree of non-occupied surface that is available within said area (3) in order to accommodate at least one further object (2);
- said processing means (5) comprising computing means (5a) designed to determine, as a function of the state detected by said sensor means (4) in the points (A), the size of the non-occupied surface that is available within said area (3) in order to accommodated at least one further object (2);
- said computing means (5a) being designed to determine, as a function of the size of the non-occupied surface, a combination of different types of objects (2), which can be arranged within the non-occupied surface.

2. The system according to Claim 1, wherein said computing means (5a) are designed to determine, as a function of said size of the non-occupied surface, the type of objects (2) that can be arranged within the non-occupied surface.

3. The system according to the Claims 1 or 2, wherein said computing means (5a) are designed to receive information indicating the type of object to be positioned within said area (3), and to verify, as a function of the free surface determined, whether said object can be set within said area (3) .

4. The system according to any one of the preceding claims, wherein said sensor means (4) are located in a plurality of points (A) of the plane surface of said area (3) according to a substantially matrix geometrical distribution.

5. The system according to any one of the preceding claims, wherein said area (3) comprises a parking area, and said objects (2) comprise means of transport.

6. The system according to Claim 5, further comprising a plurality of sensor means (11) arranged in a plurality of points (B) of a recognition area (10) according to a pre-set geometrical configuration for detecting a state of occupation or a state of non-occupation of each of said point (B) by a means of transport located in the recognition area (10) ; said processing means (5) being designed to determine, as a function of the state detected in said points (B) by said sensor means (4), the type and/or the dimensions of said means of transport.

7. A method for detecting and managing occupation of an area (3) by objects (2); comprising:

- detecting, by sensor means (3a) arranged in a plurality of points (A) distributed within the area (3), a state of occupation or a state of non-occupation of each point (A) by at least one object (2) located in the area (3) itself, when an object (2) or a portion of object (2) is above said sensor means (4a); and
- determining, as a function of the state detected in said points (A), the degree of non-occupied surface that is available within said area (3) in order to accommodate at least one further object (2);

said method being **characterized by** comprising:

- determining, as a function of the state of occupation or non-occupation detected in said points (A), the size of the non-occupied surface that is present within the area (3) in order to accommodate at least one further object; and
- determining, as a function of the size of the non-occupied surface, a combination of the types of objects that can be arranged within the non-occupied surface itself.

8. The method according to Claim 7, further comprising:

- determining, as a function of the size of the non-occupied surface, the type of objects (2) that can be arranged within said non-occupied surface.

9. The method according to Claims 7 or 8, further comprising:

- detecting in a plurality of points (B) distributed inside a recognition area (10), a state of occupation or a state of non-occupation of each point (B) by at least one object (2) set in the recognition area (10);
- determining, as a function of the state of occupation or non-occupation detected in said points (B) of the recognition area (10), the type and/or the dimensions of said object (2); and
- verifying, as a function of the type and/or of the dimensions of said recognized object (2) and on the basis of the dimensions of the free surface determined, whether it is possible or not to accommodate said object (2) in said free surface

determined.

10. The method according to any one of Claims 7 to 9, wherein said area (3) comprises a parking area, and said objects (2) comprise means of transport.

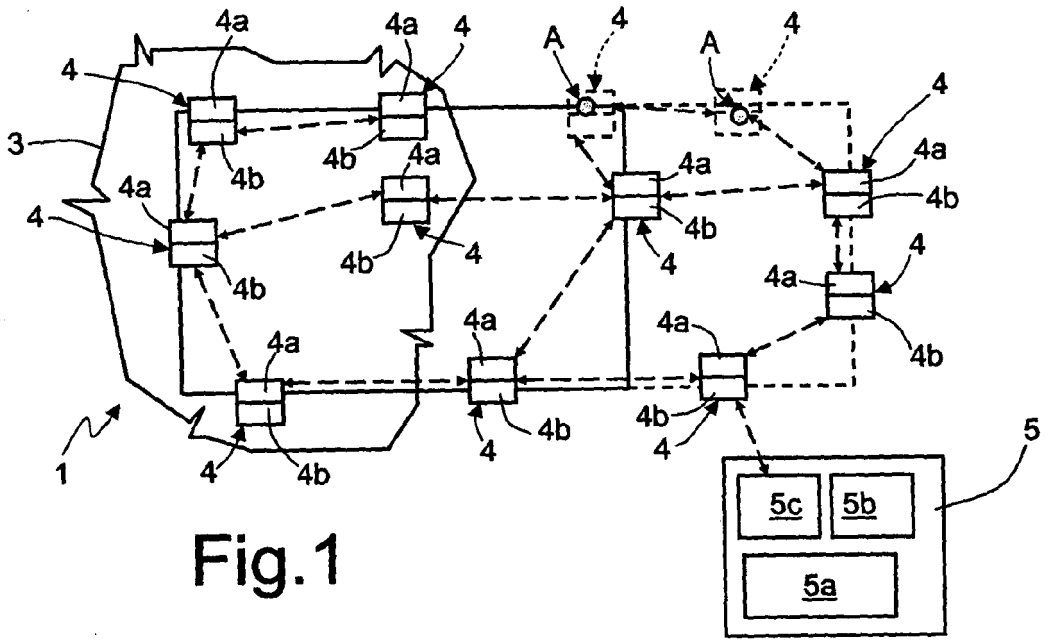

Fig.1

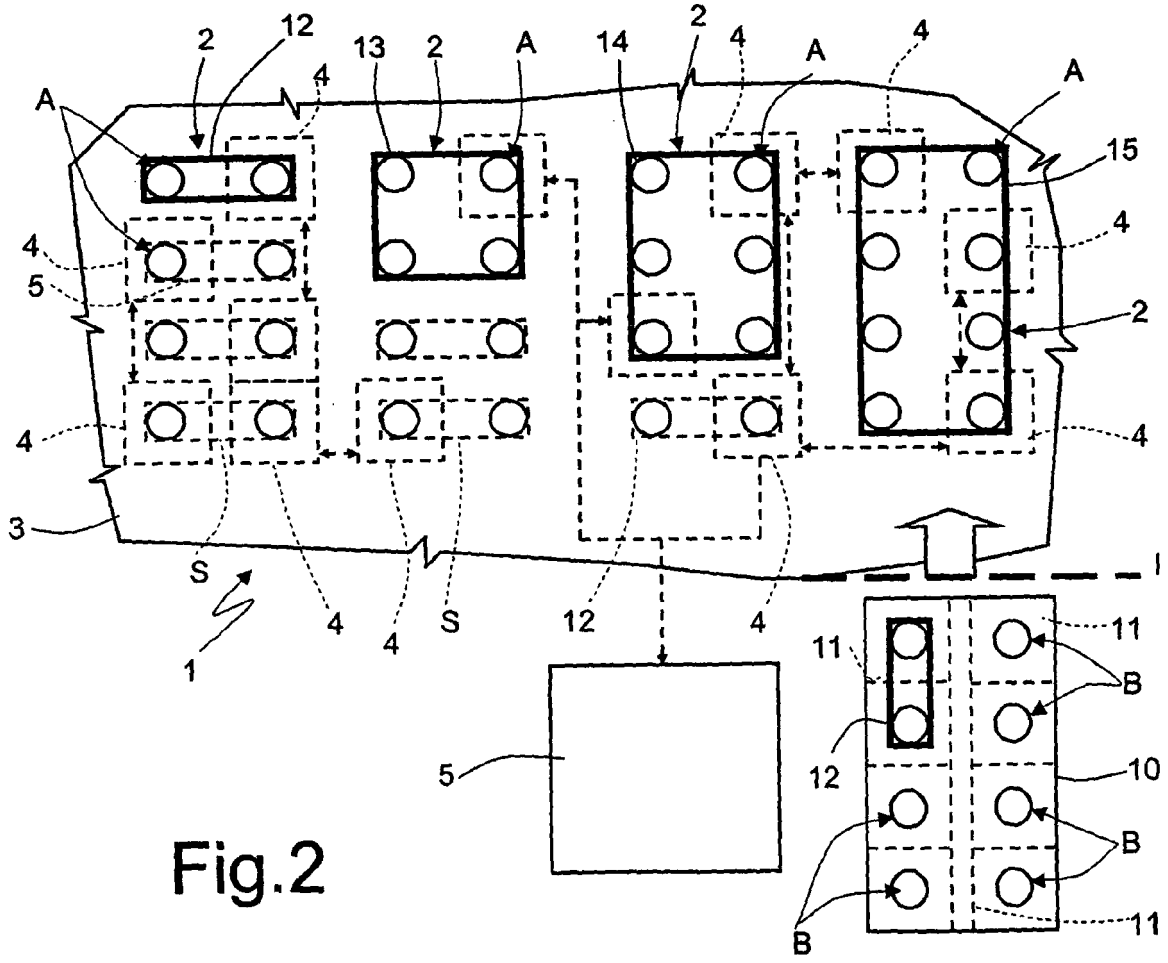

Fig.2

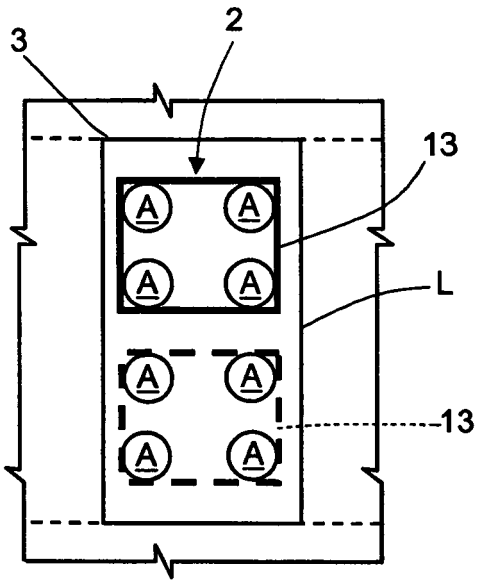

Fig.3

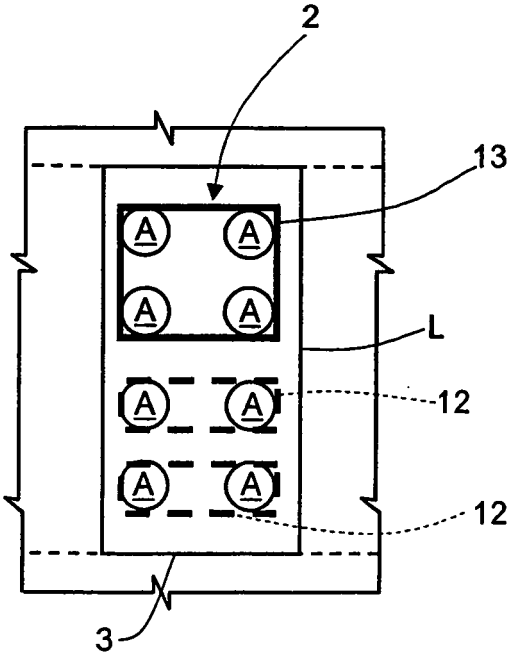

Fig.4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5053

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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Y	* paragraph [0006] - paragraph [0008] * * paragraph [0028] - paragraph [0031] * * paragraph [0046] * * figures 1,4,5 *	4,6,8,12	
X	DE 33 42 217 A1 (NAGLER METALLBAU GMBH; NAGLER METALLBAU GMBH, 8481 LUHE-WILDENAU, DE) 30 May 1985 (1985-05-30) * page 4, line 17 - page 8, line 1 *	1-3,5,7, 9-11,13, 14	
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Y	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 12, 5 December 2003 (2003-12-05) -& JP 2003 303400 A (MATSUSHITA ELECTRIC IND CO LTD), 24 October 2003 (2003-10-24) * paragraph [0003] - paragraph [0014] * * paragraph [0072] * * paragraph [0078] - paragraph [0079] *	4,12	TECHNICAL FIELDS SEARCHED (IPC) G08G E04H
Y	US 6 885 312 B1 (KIRKPATRICK MARK A) 26 April 2005 (2005-04-26) * column 5, line 22 - column 7, line 25; figure 2 *	6,8	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 June 2006	Seisdedos, M

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

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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)

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Munich	23 June 2006	Seisdedos, M

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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

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 42 5053

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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