(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
9. Februar 2017 (09.02.2017)

WIPO | PCT

(10) Internationale Veröffentlichungsnummer
WO 2017/021230 A1

(51) Internationale Patentklassifikation:
G08B 7/06 (2006.01) ***B66B 5/02*** (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2016/067817

(22) Internationales Anmeldedatum: 26. Juli 2016 (26.07.2016)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
15179304.9 31. Juli 2015 (31.07.2015) EP

(71) Anmelder: INVENTIO AG [CH/CH]; Seestrasse 55, 6052 Hergiswil (CH).

(72) Erfinder: TROESCH, Florian; Wolframplatz 14, 8045 Zürich (CH). **FINSCHI, Lukas**; Oberschachenstrasse 9, 6030 Ebikon (CH).

(81) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare nationale Schutzrechtsart)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, RU, TJ, TM), europäisches (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

[Fortsetzung auf der nächsten Seite]

(54) Title: SEQUENCE OF LEVELS IN BUILDINGS TO BE EVACUATED BY ELEVATOR SYSTEMS

(54) Bezeichnung : REIHENFOLGE VON ZU EVAKUIERENDEN STOCKWERKEN IN GEBÄUDEN MIT AUFZUGSYSTEMEN

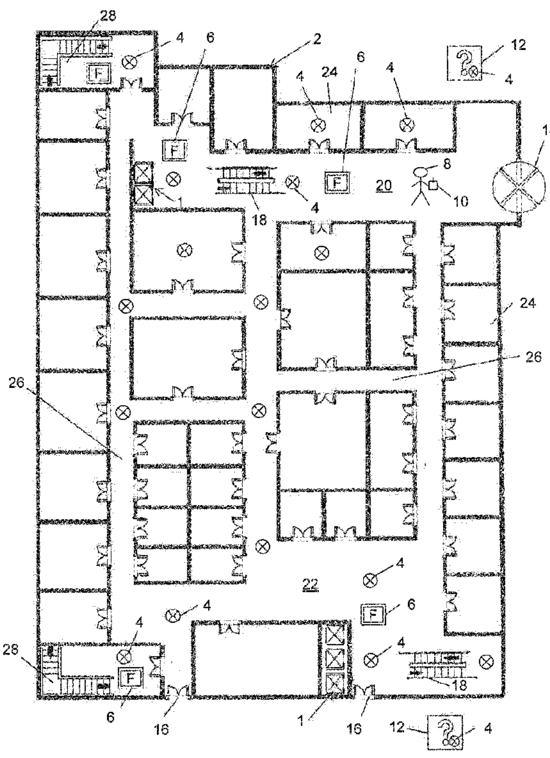


Fig. 1

(57) Abstract: During an evacuation situation in a building (2) equipped with an elevator system (1) in which building a plurality of fixed point markings (4) is arranged at specified locations, a sequence of levels (L1, L2, L3) to be evacuated is determined, according to which the elevator system (1) services the levels (L1, L2, L3). The sequence depends on the current traffic situations on the levels (L1, L2, L3). The traffic situation is in turn based on the current positions of the mobile devices (10). Said positions are each determined when a mobile device (10) accesses data received from a first fixed point marking (4) on a database (47) in which the data is linked to a location of the first fixed point marking (4).

(57) Zusammenfassung: Während einer Evakuierungssituation in einem mit einem Aufzugsystem (1) ausgestatteten Gebäude (2), in dem eine Vielzahl von Festpunktmarkierungen (4) an festgelegten Standorten angeordnet ist, wird eine Reihenfolge von zu evakuierenden Stockwerken (L1, L2, L3) ermittelt, gemäss der das Aufzugsystem (1) die Stockwerke (L1, L2, L3) bedient. Die Reihenfolge hängt von der aktuellen Verkehrslage auf den Stockwerken (L1, L2, L3) ab. Die Verkehrslage wiederum basiert auf momentanen Positionen der mobilen Geräte (10). Diese Positionen werden jeweils bestimmt, wenn ein mobiles Gerät (10) mittels von einer ersten Festpunktmarkierung (4) empfangener Daten auf eine Datenbank (47) zugreift, in der die Daten mit einem Standort der ersten Festpunktmarkierung (4) verknüpft sind.

WO 2017/021230 A1

Erklärungen gemäß Regel 4.17:

— *hinsichtlich der Berechtigung des Anmelders, ein Patent zu beantragen und zu erhalten (Regel 4.17 Ziffer ii)*

Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

Sequence of levels in buildings to be evacuated by elevator systems

Description

The technology described here relates in general to the evacuation of an building, in particular, a multi-story building, in which an elevator system is present. Embodiments of the technology pertain, in particular, to a method for determining a sequence of floors to be evacuated of a building, and a system for evacuating a building.

A method for evacuating a building is disclosed, for example, in DE 10 2013 201 873 A1. According to this method, the place of a mobile device and, therewith, the location of a person bearing the mobile device within a buiding are determined with the aid of an indoor positioning system (WLAN nodes, hotspots, access points). The mobile device reads the building plan from identifiers (QR codes or barcodes) installed in the building. Available escape paths are determined in accordance with the determined position. An escape route, e.g., the fastest path from the current location to the nearest passable emergency exit, is determined for the person from the determined location and the available escape paths. The calculated escape route is represented graphically on the mobile device. For wheelchair users, the method provides guidance to a safe place in the building—in order to wait there for a rescue team—through evacuation information.

Another approach for evacuating buildings is disclosed in WO 2014/191610. Therein, an elevator system is used to evacuate people out from the building. The method disclosed comprises determining the number of people to be evacuated for each floor, and determining whether a person to be evacuated preferentially (for example, with a physical limitation) is included among these people. The method then comprises calculating therefrom, for each floor, the estimated waiting time for evacuating, and indicates same respectively on the floor.

Although DE 10 2013 201 873 A1 and WO 2014/191610 describe solutions for evacuating people out from buildings, these solutions do not take into account changing conditions during an evacuation situation. There is a need for an improved technology for evacuating an building, with which people can be evaucated safely and efficiently from the building, even if the conditions change during an evacuation, for example, due to panicking or a rapidly-spreading fire.

One aspect of such an improved technology relates therefore to an evacuation method for a building having a plurality of floors and an elevator system. In the building, a plurality of fixed point markers are arranged at defined sites, wherein the fixed point markers store data that can be received by a mobile device carried by a person. The method comprises determining instantaneous positions of mobile devices in the building, wherein an instantaneous position of a mobile device is determined when the mobile device uses data received from a first fixed point marker to access a database in which the data is linked to a site of the first fixed point marker. A current traffic situation for each floor is determined on the basis of the instantaneous positions of the mobile devices. A sequence of the floors to be evacuated is determined on the basis of the current traffic situation on the floors.

Another aspect relates to a system for evacuating a building equipped with an elevator system. The system has a plurality of fixed point markers at defined sites, wherein the fixed point markers store data that can be received by a mobile device carried by a person. The system also comprises an elevator control through which a drive unit can be controlled in order to move an elevator car between floors of the building, as well as a safety system having a computer system. The safety system is coupled communicatively to the elevator control. The computer system executes a software program that determines instantaneous positions of mobile devices in the building, wherein an instantaneous position of a mobile device is determined when the mobile device uses data received from a first fixed point marker to access a database in which the data is linked to a site of the first fixed point marker. A current traffic situation for each floor is also determined on the basis of the instantaneous positions of the mobile devices. The software program determines a sequence of the floors to be evacuated on the basis of the current traffic situation on the floors.

In the embodiments described here, the evacuation of the building is based on the current traffic situation in the building, in particular, on the floors. Determining the traffic situations makes it possible to better plan or optimize escape routes, because the traffic situation is an indicator of whether certain escape routes have already been overloaded due to the number of people, or will have been overloaded shortly, or can still accommodate the traffic to the normal extent. If an escape route has become overloaded, then, for example, hallways, stairwells, or elevators become crowded with people, reducing the efficiency of the evacuation, causing elevators to malfunction because of door blockages, and increasing the risk of panic breaking out. The embodiments described here take the traffic situation into account in order to, for example, avoid guiding more people along overloaded escape routes or escape routes currently at the capacity limit. This increases the likelihood that an overloaded escape route will more quickly normalize back or will not even enter an overloaded state.

Awareness of the traffic situation is also, as discussed above, involved in the determination of the sequence of the floors to be evacuated. The sequence determines which floor is evacuated when. A floor that has a low traffic volume may, for example, be evacuated before a floor that has a high traffic volume if the evacuation is to take place to a floor on which the planned escape route that is only able to accommodate a small number of people without hitting the capacity limit thereof. If, by contrast, the planned escape route still has enough capacity to accommodate a large number of people, the floor that has the high traffic volume is evacuated before the floor that has the low traffic volume. If a plurality of elevators are available, it is possible, for example, to first direct them to the floor that has the highest traffic volume, in order to quickly evacuate the greatest number of people possible. On the basis of the traffic volume, it may also be determined what transport capacity must be provided by the elevator system (in one iteration or repeatedly) in order to evacuate a floor. In one embodiment, each elevator car is equipped with a fixed point marker. This makes it possible to determine the number of people in the elevator car. The elevator system may use this information in order to, for example, ascertain whether and for how many more people there is still room in the elevator car. For the aforementioned options, corresponding rules may be defined in the software program.

In one embodiment, a floor may be divided into a plurality of zones, e.g., into a north side and a south side. In such a case, a sequence within the floor may also be determined. For example, depending on the traffic volume, the north side may be evacuated before the south side.

In one embodiment, evacuation information may be sent to a mobile device of which the instantaneous position has been determined. The evacuation information is individual for the mobile device, and comprises instructions for a person with whom this mobile device is associated. The evacuation information may, for example, provide notification that there is an emergency, that evacuation of the building has started, that there is no danger on the floor on which the person is present, that the person should not yet go to the elevator but instead after "x" minutes, and/or that the person should proceed immediately to the elevator indicated. The evacuation information may also inform the person that a nearby stairwell is accessible and the person, if able to use stairs, may possibly reach the destination faster than with an elevator.

If the sequence has been determined, the elevator system is in one embodiment controlled in accordance with the determined sequence. The elevator system controls and drives the elevator car(s) in accordance with the determined sequence.

In one embodiment, available escape routes to a destination are ascertained for each mobile device of which the instantaneous position has been determined. The ascertainment of the available escape routes is based on the instantaneous position of a mobile device. In one embodiment, instantaneous positions for which available escape routes include use of the elevator system are identified. The sequence of the floors to be evacuated is determined on the basis of the current traffic situation on the floors and the identified instantaneous positions.

The technology in one embodiment uses a current building situation in order to ascertain a safe escape route. For this purpose, in one embodiment, the building has present therein a system of sensors with which situation parameters can be ascertained. During an emergency, the situation is subject to change at any time, because, for example, a fire has spread out and previously available escape routes are no longer available. The situation parameter(s) determined—in one embodiment—provide(s) insight about the building situation (for example, whether accesses to the elevators are free and whether the elevators themselves are usable), and may be taken into consideration when the sequence of the floors to be evacuated is being ascertained.

In one embodiment, escape route information is transmitted to each mobile device of which the instantaneous position has been determined. The escape route information may, in one design, comprise elevator information, for example, indications of which elevator is to be used. In this or another design, the escape route information may comprise a waiting time to arrival of an elevator car to the floor on which the mobile device receiving the escape route information is located. The escape route information contributes to conveying a greater sense of safety to the person, and reducing the risk of panic.

The technology also makes it possible to determine a person-specific escape route, i.e., any physical limitations that the person to be evaucated may possibly have can be taken into account when the escape route is being determined. For this purpose, in one embodiment, a stored user profile of the person, in which any physical limitations that the person may have are stored, may be accessed. In another embodiment, the movement of a person may be analyzed in order to recognize whether there is a physical limitation. If, for example, walking ability is limited, such that the person needs to use a wheelchair, the escape route must not include any stairs; instead, in such a case, use of the elevator system is included in the planning of the escape route. The planning may be such that an elevator car is moved to the floor on which the escape route proceeds, so that it is, for example, already ready to be boarded when the person arrives there. If, on the other hand, vision is impaired, the escape route information is transmitted to the mobile device with a control command so that the escape route information is communicated audibly to the person.

Various aspects of the improved technology are explained in more detail below using exemplary embodiments in conjunction with the figures. Like elements have like reference signs in the figures. In the drawings,

Fig. 1 illustrates a schematic representation of an example of a situation on a building floor served by two elevator systems;

Fig. 2 illustrates a schematic representation of an example of a communication system for evacuation of a building;

Fig. 3 illustrates a schematic representation of a mobile device that can indicate escape route information;

Fig. 4 illustrates a schematic representation of a part of the building with an embodiment of an elevator system; and

Fig. 5 illustrates an example of a representation of an evacuation method for a building having a plurality of floors and an elevator system.

Fig. 1 is a schematic representation of an example of a situation on a floor of a building 2 that is to be entirely or partially evacuated safely and efficiently during an emergency (e.g., a fire, a natural catastrophe, or a terror situation). The term "evacuation" is to be understood here to mean clearing out an area, wherein the area may be a building, a part of a building, a building with an adjoining site, or another structure (e.g., a ship) suitable for visitation by people. People who are staying in an area to be evacuated must leave the area or at least go to a destination that is provided there and considered safe. The technology described here is not limited to evacuation of buildings (e.g., apartment homes, offices and corporate buildings, hotels, sports arenas, airport buildings, and factories). A person skilled in the art will recognize that the technology can also be used, for example, to evacuate other structures (e.g., ships).

The building 2 can be entered and left through a main entrance 14 and two side entrances 16. Depending on the design, the side entrances 16 may also be provided as emergency exits, and thus exclusively for use during an emergency. Outside of the building 2, near these entrances 14, 16, are gathering points 12 at which people are to turn up after leaving the building 2 in an emergency, in order to be registered there as having been "evacuated". For the people, the gathering points 12 represent destinations at the end of escape routes. The gathering points 12 may be installed permanently in an environment of the building 2. The gathering points 12 may also be set up as temporary in the environment, as necessary, for example, during an evacuation situation, for example, fixed to a stand or a vehicle.

Alternatively to the aforementioned possibility of registering evacuated people as having been "evacuated" at the gathering points 12, there may be corresponding devices (for example, the beacons described hereinbelow) provided at the entrances 14, 16 of the building 2 and/or at special checkpoints or turnstiles within the building 2, in order to recognize people as being present at these places and register them as having been "evacuated". It is also possible to install such devices in elevator cars 49 (see fig. 4) and/or entrances thereof, in order, for example, to recognize people leaving an elevator car. This makes it possible, for example, to establish that a person has arrived, for example, at a "safe" floor.

The main entrance 14 leads to an entrance area 20, and the side entrances 16 lead to an entrance area 22. The entrance areas 20, 22, are also called lobbies 20, 22 (respectively) hereinbelow. From each lobby 20, 22, a person 8 has access to an elevator system 1, an escalator installation 18, and a stairwell 28, in order to reach another floor. From the lobbies 20, 22, the person 8 also has access to halls and corridors 26 and individual rooms 24.

Within the building 2, fig. 1 also illustrates emergency alarms 6 of an alarm system that has, for example, devices for detecting temperature, smoke, and/or gas and optionally triggers an alarm. Hereinbelow, the emergency alarms 6 are fire alarms (6) of a fire alarm system. For the purpose of better viewing, fig. 1 depicts fire alarms 6 only in the stairwells 28 and the lobbies 20, 22. It shall, however, be understood that a plurality of these fire alarms 6 are arranged in accordance with any existing fire protection regulations in the rooms 24, the halls and corridors 26, and the elevator systems 1 (e.g., in an elevator shaft 38 illustrated in fig. 4), and connected by means of a network to a fire alarm control center (not shown) and/or a building management system 42 illustrated in fig. 2. The arrangement of the fire alarms 6 and the interconnection thereof may be documented in a building plan or building model. The communication in this network takes place in one embodiment according to a network protocol for building automation, for example, the BACnet (Building Automation and Control Networks). Fire alarm systems and components thereof, e.g., fire alarms 6 are generally known, such that further elaboration thereof is not needed here.

In addition to such fire alarm systems, the building 2 also, under certain circumstances, has sensors that are provided for detecting or observing different events and may also be documented in the building plan or building model. For example, motion sensors may be arranged distributed through the building 2. Moreover, video cameras 11 (see fig. 4) may be arranged, for example, in the halls and corridors 26, the entrances 14, 16, and in the lobbies 20, 22. Security personnel or an image processing system may, for example, evaluate images captured by the video cameras 11, in order to assess the current situation in individual areas in the building 2, for example, whether a hall or corridor 26 is blocked or accessible, whether there is a gathering/congestion of people at a place, and/or what the extent of a fire reported there is. The signals of the sensors and the evaluation of the recorded events may, in connection with signals from the fire alarms 6, provide current situation parameters that, for example, provide insight on whether the accesses to the elevators are free and whether the elevators theremselves are usable. Signals generated from the fire alarms 6 and the sensors and the evaluation thereof may be taken into account in the determination of an escape route, as described hereinbelow.

Fig. 1 also illustrates a plurality of fixed point markers 4 that are arranged at different places within the building 2. The fixed point markers 4 are arranged, for example, in areas that the person 8 can visit, examples thereof including the rooms 24, the corridors and halls 26, the stairwells 28, and the lobbies 20, 22. Also, for the purpose of better visibility, fig. 1 only illustrates some of the fixed point markers 4, and only some thereof are provided with reference signs. As illustrated in fig. 1, fixed point markers 4 are also present at the gathering points 12. The arrangement of the fixed point markers 4 may also be documented in a building plan or building model. The gathering points 12 may, alternatively thereto, be only temporarily equipped with fixed point markers 4, as needed. As mentioned above, the gathering points 12 may, as necessary, be set up temporarily and movably at a destination, e.g., in the environs of the building 2. This may be advantageous if a location of a gathering point 12 and the number thereof need to be set up flexibly and, for example, in accordance with the type and/or scale of the emergency and the number of people to be evacuated.

In one embodiment, a mobile device 10 carried by the person 8 is configured in order to receive data from a fixed point marker 4 (e.g., an identification number thereof), by means of which data an instantaneous location of the mobile device 10 can be determined. The receipt occurs contactlessly, e.g., through scanning of an optical code (e.g., a QR code, bar code, or color code), or production of a radio link based on one of the known technologies for near field communication (NFC), Wi-Fi Direct, RFID, or Bluetooth.

Hereinafter, the mobile device 10 is a Bluetooth-capable smartphone, and the fixed point markers 4 are also accordingly Bluetooth-capable. A fixed point marker 4 is therefore hereinafter called a "beacon 4" or "Bluetooth beacon 4". The communication between the smartphone (10) and the beacons 4 thus takes place according to the Bluetooth standard, e.g., the Bluetooth Standard 4.0 (Bluetooth Low Energy (BLE)) or another Bluetooth standard.

Irrespective of the standard selected, a beacon 4 always emits the same data, e.g., the identification number thereof (e.g., "ID = 5"). If the mobile device 10 is in the radio range of the beacon (with the Bluetooth function activated), a communication link is automatically established, and the mobile device 10 receives the emitted data, and recognizes thereby that it is, for example, in the vicinity of the beacon 4 with the "ID=5". Correspondingly, the connection is interrupted if the mobile device 10 moves back out of the radio range. A person skilled in the art will recognize that pairing known from Bluetooth technology is not provided in one embodiment, for example, due to the large number of beacons 4 distributed through the building 2, and any (one-time) visitors who may be visiting the building 2. If, however, it should be provided, then it is accepted here that a first communication contact (i.e., the pairing) has already occurred between the mobile device 10 and the beacons 4. In the pairing, the communication partners exchange characteristic data so as to automatically recognize each other again the next time.

Fig. 2 illustrates the interactions of the mobile device 10 with the beacon 4 and with systems (1, 42, 44) coupled to a communication network 46. In one embodiment, each beacon 4 stores an individual identifier (e.g., "ID=5") that is transmitted to the mobile device 10 when there is a comunication link. The mobile device 10 (or an installed software application) uses the received identifier of a beacon 4 to access, by means of a radio link, a database 47 in which the identifier is linked to data on a site at which this beacon 4 is arranged (e.g., "ID=5" in the lobby 20 at the access to the escalator installation 18). The identifier of the beacons 4 and the data on the location thereof form a data set in the database 47. The number of such data sets corresponds to the number of the beacons 4. The database 47 may be present in a storage system of a building management system 42 (building controller) or a storage system of a separate safety system 44 (security system) of of the elevator system 1. This is indicated in fig. 2 with dotted lines between the database 47 and the systems 1, 42, 44. The access to the database 47 may take place over the communication network 46 (e.g., WLAN, Internet), during which an identification parameter (e.g., telephone number and/or device ID code (Media Access Control (MAC) address)) of the mobile device 10 accessing the database 47 is also transmitted.

In the view of the building management system 42 or the safety system 44, on the one hand, it is recognized—with the access to the database 47—which mobile device 10 is present in the vicinity of the beacon 4 with "ID=5". On the other hand, the mobile device 10 acquires data pertaining to the location of this beacon 4 and therewith its own location. If the person 8 moves within the building 2, including use of the elevator system 1 or the escalator installation 18, the process described repeats once there is a communication link between the mobile device 10 and another beacon 4. In the view of the building management system 42 or the safety system 44, this makes it possible to track the movement of the mobile device 10. In the view of the person using the mobile device 10, in the case of evacuation, this enables orientation or at least provides an orientation aid, for example, because the mobile device 10 of the person 8 conveys perceivable location information to the person.

A person skilled in the art will reocgnize that the interactions described in connection with fig. 2 constitute a type of sensor function. The safety system 44 may—for example, from the number of accesses to the database 47—deduce how many passenger transports are prevailing at the moment in the building 2, how many and few passenger transports are prevailing, in which directions the transport is moving (both in the horizontal direction and in the vertical direction), and where the transport may possibly come to a standstill (e.g., a plurality of mobile devices 10 use the identifier of the same beacon 4 to access the database 47 (possibly repeatedly) but do not move to another beacon 4). This information, too, may be employed as a parameter for the current traffic situation for calculating an escape route and the sequence of the floors to be evacuated.

In one embodiment, the mobile device 10 has installed thereon a software application (app) that supports the communication with the beacons 4 and the units (1, 42, 44) coupled to the communcation network 46. Authorized people (e.g., regular users of the building 2) may pre-install the app on their mobile device 10. A visitor may, on entering the building 2, receive an offer to download the app on his or her mobile device 10.

The app also controls a user interface (comprising, e.g., a touch-sensitive display) with which, for example, location and/or escape route information can be conveyed to the person 8. The location and/or escape route information may be represented in readable form on the display, e.g., in the form of text and/or one or more symbols. The information may also be represented alone or in connection with a representation of the building plan or model. In addition or alternatively thereto, the location and/or escape route information may also be conveyed acoustically to the person 8, so that, for example, even people with limited vision can receive the location information and react accordingly.

Fig. 3 illustrates a smartphone as an example of a mobile device 10. Arranged therein are a storage device 48 (memory) and a process 50, under a display 52 (touch screen) so as not to be visible from the outside (and therefore indicated with dotted lines). With the aid of the user interface, the person 8 can make individual adjustments to the settings and desired functions on the mobile device 10. The Bluetooth function may, for example, be activated and deactivated; the latter, for example, for the protection of privacy, because the movements and whereabouts of the person 8 in the building 2 cannot be tracked without the Bluetooth function. Morever, the aforementioned app may be activated and deactivated by the person 8. In the emergency, for example, with a fire alarm, the person 8 may activate the Bluetooth function and the app. Depending on the design, the app may be activated automatically, or always be activated when the mobile device 10 is turned on.

The smartphone, as an example of a mobile device 10, conveys escape route information to the person 8. The escape route information may, in one embodiment, be indicated on the display 52, e.g., as text, graphic symbols (e.g., arrows), maps, and/or images of places). The escape route informations inform or instructs the person 8, for example, about where he or she should go next, and/or how great the distance to the next waypoint or exit is. If the escape route includes use of the elevator system 1, it may also be conveyed to the person 8, for example, which elevator should be used, when it is arriving at a certain floor, and/or how long the waiting time to the arrival of an elevator car is. In addition or alternatively thereto, the information may also be presented to the person 8 as an audio message. A person skilled in the art will recognize that the escape route information may also be conveyed to the person 8 by means of so-called smartwatches or other wearables (e.g., eyeglasses with a display, possibly in connection with technology that enables an augmented reality function).

For an understanding of the vertical situation in the building 2, fig. 2 illustrates a side view of a part of the building 2 illustrated in fig. 1, with one embodiment of the elevator system 1. The building 2 has a plurality of floors L1, L2, L3, on each of which a plurality of fire alarms 6 and beacons 4 have been arranged. In addition, a beacon 4 is arranged in an elevator car 49, so that, for example, it can also be recognized that the person 8 is present at the moment in the elevator car 49 and that the elevator car 49 is traveling to a "safe" floor. This makes it possible to determine the number of people in the elevator car 49. The elevator system may use this information in order to, for example, ascertain whether and for how many more people there is still room in the elevator car 49. The direction of travel and the destination floor are present in the elevator system 1 as information. The fire alarms 6 are here interconnected through a network 43 of a fire alarm system to the building management system 42, in which a fire alarm central command may also be integrated. In the embodiment illustrated, the video camera 11 is also coupled to the network 43, wherein at least one videocamera 11 may be arranged on each floor L1, L2, L3. The floors L1, L2, L3 are served by the elevator system 1, i.e., the person 8 can be transported by the elevator system 1 from a boarding floor to a destination floor. The vertical situation of the building 2 is also documented in the building plan or building model.

Fig. 4 does not include an illustration of the escalator installations 18 illustrated in fig. 1; however, it shall be understood that an escalator installation 18 also serves to vertically transport people. Each escalator installation 18 has its own control device, which may have a communication link to the building management system 42 and/or the safety system 44. In an emergency, this makes it possible to set the escalator installation 18 in a fixed operating mode (including being stationary). In one operating mode, an escalator installation 18 may be controlled with respect to the direction of travel thereof so as, for example, to make available a greater transport capacity in the direction of the exit or the destination in the currently-necessary direction in accordance with the transport need.

The elevator system 1 illustrated in fig. 4 is, for example, equipped with a destination call control, wherein destination calls can be made via terminals 54 installed on the floors L1, L2, L3. The function of the destination call control is implemented in the embodiment illustrated in a control device (Ctrl) 30, but can also be entirely or partially implemented in an elevator control 32. The control device 30 and the elevator control 32 may be combined into one control device (30, 32). The elevator control 32 is, in the embodiment illustrated, also communicatively connected to the building management system 42 and the safety system 44. The elevator control 32 also controls a drive unit 34 that transports the elevator car 49 in the shaft 38 by means of a support means 36.

In one embodiment, a destination call may be placed with the aid of an information carrier, e.g., in the form of a credit card or an employee ID. Depending on the design, a memory chip that can be externally contacted, an RFID transponder in conjunction with a memory chip, or an externally optically readable code, e.g., a QR code or bar code, is located in or on the information carrier. Alternatively thereto, the functionality of the information carrier may also be implemented on the mobile device 10. The displays of such devices can display, for example, QR codes, barcodes, or color pattern codes. A reading device compatibility with the technology of the information carrier used reads, for example, an identification number from the information carrier.

The identification number is used in one embodiment in order to access a profile (data set) that has been created for the user of the information carrier, i.e., data is read out from a data set. Such a profile may store, for example, a destination floor and/or other person-specific information (e.g., VIP status, type of any kind of physical limitation (limited vision, wheelchair user)). The elevator control 32 can access this profile and therewith, for example, adapt the manner of operation of the elevator system 1 to a user with a physical limitation, for example, holding the elevator doors open longer so that a wheelchair user or a mobility-impaired user can board comfortably.

In one embodiment, the safety system 44 may also access this profile and recognize whether the person 8 whose mobile device 10 is accessing the database 47 has, for example, a physical limitation. If there is such a limitation, this information may also be involved in the ascertainment of an escape route for this person 8. Thus, for example, the escape route for a wheelchair user must not include any stairs; instead, an elevator ride should be included in the planning (provided that the elevator system 1 is operational) when the escape route requires changing floors.

The planning may be such that an elevator car 49 is moved to the floor on which the escape route proceeds, so as to, for example, already be ready to be boarded when the person 8 arrives there. If, however, vision is impaired, the escape route information is transmitted to the mobile device 10 together with a control command ensuring that the mobile device 10 conveys the escape route information audibly to the person.

Above, it is indicated that registered users have the ability to register special needs (e.g., because of a physical limitation) in advance, i.e., for example, to store same in a user profile. Alternatively thereto, information regarding such special needs may also be stored only locally with the user, e.g., on the mobile device 10 of the person 8, and only transmitted in actual use to, e.g., the elevator control 32. In another design, special needs may also be determined without prior registration or storage, e.g., via additional functions in the app or through analysis of a person's motion, e.g., how he or she moves or behaves (e.g., the person's travel speed (e.g., measuring the time to covering a known distance between two beacons) or use of stairs).

The building management system 42 and the safety system 44 are each microprocessor-controlled computer systems in which task-specific computer programs are executed. For illustration, fig. 2 depicts the safety system 44 with an integrated computer system (μP) 44a. The building management system 42 generally takes on control tasks of the communication, housing technology, and danger alarm installations and simplifies the operation and supervision of these installations. It supports, in particular, the operator or administrator of a building in operational safety tasks; for example, in the case of an alarm, it automatically makes available detailed information in textual or graphic form for possible procedures at the alarm site. As other functions, for example, the building management system 42 gives alarm warnings for intervention teams or places to be notified, makes available overviews of the current danger situation, and records in-depth reports and activities carried out.

In the embodiment described here, the functionality of evacuating is implemented in the safety system 44. For this purpose, the safety system 44 is communicatively linked to the building management system 42 and to the elevator system 1, in order to control and monitor the safe and efficient evacuation of the building 2 in the event of an emergency. It shall be understood, however, that in another embodiment, the functionality of evacuating may also be implemented in the building management system 42 or elevator system 1, and that the aforementioned functionalities may be consolidated into one system. A separate representation of the safety system 44 may then be forgone.

With the understanding of the principal structure and functionalities of the building and systems thereof (in particular, the building management system 42, the fire alarm system, and the elevator system 1) described in connection with fig. 1 to fig. 4, there follows a description of embodiments of a method for evacuating the building 2 having a plurality of floors L1, L2, L3 and an elevator system 1, with reference to fig. 5. A person skilled in the art will recognize that the schematic flow chart illustrated may comprise more or fewer steps, depending on a concrete embodiment. In connection with the description of fig. 5, it is assumed that the there are a plurality of mobile devices 10 located in the building 2, and that each mobile device 10 is a smartphone with an app activated, that people 8 carry on a floor of the building 2, according to the situation illustrated by way of example in fig. 1. The method is then executed, by way of example, in the computer-controlled safety system 44. The method according to fig. 5 begins in a step S1 and ends in a step S8.

If the building management system 42 establishes by means of the fire alarms 6 that a fire has broken out in the building 2, it initiates an emergency procedure comprising, for example, warning people by means of acoustic and visual alarms, closing fire doors, and transferring the elevator systems 1 and the escalator installations 18 into an emergency mode. In such an emergency mode, for example, (destination) calls either cannot be entered or are ignored by the elevator control 32. The building management system 42 also sends an alarm signal to the safety system 44, which thereupon initiates evacuation of the building 2. The building management system 42 may also prompt, for example, the safety system 44 to send out automated notifications to the people 8 located in the building 2, or to the mobile devices 10, for example, with the request to leave the building 2. If the mobile device 10 receives the notification, the software application (app) may be activated thereby in one embodiment. Correspondingly, in one design, other people may also be informed, for example, those who are not in the building 2 at the moment or may possibly be en route to the building 2.

In a step S2, instantenous positions of the mobile devices 10 within the building 2 are determined. The positioning is done, as described above, by a mobile device 10 accessing the database 47 in which the identifier of the beacon 4 received by the mobile device 10 is linked to the location thereof in a dataset. The situation illustrated in fig. 1 involves, for example, a communication link to the beacon 4 in the lobby close to the escalator installation 18 so that the mobile device 10 receives the identifier of this beacon 4.

A person skilled in the art will recognize that the step S2 may be executed independently of the step S1 and before the step S1. The position of the mobile device 10 may, for example, be determined and transmitted to the safety system 44 continuously and in the absence of any triggered evacuation.

In a step S3, a current traffic situation is determined for each floor L1, L2, L3. For this purpose, the safety system 44 executes a software program that assesses the accesses to the database 47 and—for example, from the number of accesses to the database 47—deduces how many passenger transports are prevailing at the moment in the building 2, how many and few passenger transports are prevailing, in which directions the transport is moving (both in the horizontal direction and in the vertical direction), and/or where the transport may possibly come to a standstill (e.g., a plurality of mobile devices 10 use the identifier of the same beacon 4 to access the database 47 (possibly repeatedly) but do not move to another beacon 4).

In one embodiment, the method proceeds from step S3 directly to a step S6, which is indicated by a dotted line L in fig. 5. In the step S6, a sequence of the floors L1, L2, L3 to be evauated is determined. If floor is divided into a plurality of zones, e.g., into a north side and a south side, the determination of the sequence may also comprise determining a sequence within the floor. The determination is based on the current transport situation on the floors L1, L2, L3 determined in step S3. In order to determine the sequence for this building 2, rules that may be defined in the software program are put to use, as mentioned above. These rules may, for example, define that floors having a high traffic volume are to be evacuated before floors having a low traffic volume, in order to quickly evacuate the greatest possible number of people, or that upper floors are to be evaucated before lower floors.

In another embodiment, the method proceeds from the step S3 to a step S4 in which available escape routes are determined for each mobile device 10 of which the instantenous position has been determined in step S3. The software program, in one embodiment, calculates possible escape routes with the aid of the building model created for the building 2 and the information from the aforementioned evaluation of the situation parameters (e.g., the signals from the sensors and the fire alarms 6), the accesses to the database 47, and/or the evaluation of the user profile. The software program checks whether these escape routes are in principle available and are not possibly blocked or overloaded, and whether they are suitable for the person 8 in light of any possible physical limitations. Methods for calculating escape routes within buildings are known, for example, from Pu, S. and Zlatanova, S., "Evacuation Route Calculation of Inner Buildings", in "Geo-Information For Disaster Management", First International Symposium on Disaster Management, pp. 1143-1161, Springer Publishing, 2005. This publication describes, *inter alia*, creating 3-D building models and taking into account factors that may change during an emergency, e.g., a damage state (e.g., blocked routes), power failure, and reduced capacity of escape routes.

In a step S5, instantaneous positions for which available escape routes include use of the elevator system 1 are identified. In the building 2, not every escape route requires using the elevator system 1, for example, people 8 on the ground floor (e.g., floor L1) can leave the building 2 directly. For people in the first and possibly in the second floor from the ground, as well, escape routes that go through the stairwells 28 or the escalator installations 18 (the directions of travel of which, as described above, may be controlled as appropriate in the emergency) and thus do not require using the elevator system 1 are planned—provided that there are no physical limitations. If, by contrast, a person has a physical limitation, use of the elevator 1 is included in the planning, even if this person is located on the first floor from the ground. In one embodiment, a rule may set forth from which floor it is no longer optimal or reasonabel to use the stairwells 28.

If, in this embodiment, the method proceeds from the step S5 to the step S6, a sequence of the floors L1, L2, L3 to be evacuated is determined. The determination is based on the current transport situation on the floors L1, L2, L3 (step S3), the determined instantaneous positions (S4), and current situation parameters. A rule may define, for example, that a floor that has a low traffic volume is evacuated before a floor that has a high traffic volume if the evacuation is to take place to a floor on which the escape route that is only able to accommodate a small number of people without hitting the capacity limit thereof. If, by contrast, the planned escape route still has enough capacity to accommodate a large number of people, the floor that has the high traffic volume is evacuated before the floor that has the low traffic volume.

In a step S7, the elevator system 1 is controlled in accordance with the determined sequence. In one embodiment, the safety system 44 controls the elevator control 32, by transmitting the sequence of floors to be evacuated determined in the step S6 to the elevator control 32. The elevator control 32 then moves the elevator car(s) 49 in accordance with the sequence determined.

In one embodiment, the software program selects—from among the available escape routes—an escape route that is the fastest and most efficient at leading to a destination, for each mobile device 10. Information on the determined escape route is transmitted to the mobile device 10 in order to therewith help the person to quickly and safely leave the building 2. The information may be represented so as to be readable for the person 8 on the display 52, e.g., as text and/or graphics. In addition or alternatively thereto, the information may also be presented to the person 8 as an audio message.

The information on the determined escape route may, in one embodiment, comprise elevator information, for example, indications of which elevator is to be used. In addition or as an alternative thereto, the information on the determined escape route may comprise indications on the arrival of an elevator car 49, for example, the remaining wait time until the arrival.

In one embodiment, there may be monitoring of whether the person 8 also actually reaches the destination, i.e., the gathering point 12 after the escape route has been transmitted. If the person 8 has reached the destination, there is established a communication link that is registered in the safety system 44 between the mobile device 10 borne by the person and the beacon 4 present at the gathering point 12. The person 8 is considered thus as having been "evacuated".

In one embodiment, each communication link continues to be detected when established between the mobile device 10 with a beacon 4. If the person 8 moves away from the original position, a new communication link is established with another beacon 4, and the new position of the mobile device 10 in the building 2 is determined. Thus, the movement of the mobile device 10 is tracked through determination of new positions of the mobile device 10, e.g., until the person 8 is registered at the destination as "evacuated".

This makes it possible to track the movement of the mobile device 10 and recognize deviations from the escape route. One embodiment involves checking whether a newly-determined position of the mobile device 10 deviates from the determined escape route. If there is no deviation, the person 8 reaches the destination, i.e., the gathering point 12. A deviation may, however, occur when the person 8 gets lost, for example, due to poor visibility and/or panicking, or when the person 8 must change course because the escape route provided has become blocked or overloaded in the meantime.

If there is a deviation, a new escape route is determined on the basis of the last determined position. The new escape route is determined as described above. The new escape route information is transmitted to the mobile device 10. If the person 8 follows the new escape route, he or she reaches the gathering point 12 and is registered there.

The new escape route information may, for example, request that the person turn back in order to return back to the originally-determined escape route. This may be the case, for example, when it is quickly recognized that there is a deviation and that the person has strayed only slightly from the escape route. The newly-determined escape route therefore comprises the route back (i.e., the route back to the original escape route) and the original escape route (or the remaining part of the original escape route). If, on the other hand, the person 8 has continued to stray from the escape route, an escape route that either does not coincide or coincides only partially with the original escape route may be determined from the instantaneous location. From the person 8's perspective, this is still the current escape route information, irrespective of whether and how the original escape route needed to be updated.

If the escape route is updated, the person 8's attention may be brought thereto, for example, through a warning notice, in order to ensure that the person 8 also takes note of the warning notice. For this purpose, a corresponding message may be sent to the mobile device 10. The mobile device 10 responds by generating an audible signal or notification, a readable notification, and/or vibration of the mobile device 10.

Claims

1. A method for evacuating a building (2) having a plurality of floors (L1, L2, L3) and an elevator system, wherein a plurality of fixed point markers (4) are arranged in the building (2) at defined sites, wherein the fixed point markers (4) store data that can be received by a mobile device (10) carried by a person (8), comprising:

determining instantaneous positions of mobile devices (10) in the building (2), wherein an instantaneous position of a mobile device (10) is determined when the mobile device (10) uses data received from a first fixed point marker (4) to access a database (47) in which the data is linked to a site of the first fixed point marker (4);

determining a current traffic situation for each floor (L1, L2, L3) on the basis of the instantaneous positions of the mobile devices (10); and

determining a sequence of the floors (L1, L2, L3) to be evacuated on the basis of the current traffic situation on the floors (L1, L2, L3).

2. Method according to claim 1, also comprising determining—if a floor (L1, L2, L3) to be evacuated has been subdivided into a plurality of zones—a sequence according to which the zones are to be evacuated.

3. Method according to either of claims 1 and 2, also comprising sending evacuation information to a mobile device (10) of which the instantaneous position has been determined, wherein the evacuation information is individual for the mobile device (10), and comprises instructions for a person (8) with whom this mobile device (10) has been associated.

4. Method according to any of the preceding claims, further comprising controlling the elevator system (1) in accordance with the determined sequence.

5. Method according to any of the preceding claims, further comprising determining available escape routes for each mobile device (10) of which the instantaneous position has been determined to a destination (12) on the basis of the instantaneous position of the mobile device (10).

6. Method according to claim 5, further comprising identifying instantaneous positions for which available escape routes include use of the elevator system (1), wherein the identified available escape routes are used to determine the sequence of the floors (L1, L2, L3) to be evacuated.

7. Method according to any of the preceding claims, further comprising determining a situation parameter by means of a system of sensors (6, 11) present in the building (2), wherein the situation parameter is used to determine the sequence of the floors (L1, L2, L3) to be evacuated.

8. Method according to any of claims 5-7, further comprising transmitting escape route information to each mobile device (10) of which the instantaneous position has been determined.

9. Method according to claim 8, in which the escape route information comprises an indication of an elevator to use and/or a waiting time to arrival of an elevator car (49) to the floor (L1, L2, L3) on which the mobile device (10) receiving the escape route information is located.

10. Method according to any of the preceding claims, further comprising determining whether a person (8) has a physical limitation, wherein, if the person (8) has a physical limitation, this is used as a parameter for determining the sequence of the floors (L1, L2, L3) to be evacuated.

11. Method according to claim 10, in which whether a person (8) has a physical limitation is determined by means of access to a user profile in which a physical limitation has been registered or by means of analysis of the person (8)'s movement.

12. Method according to any of the preceding claims, in which the fixed point markers (4) are equipped with Bluetooth technology.

13. System for evacuating a building (2) equipped with an elevator system (1), comprising:

a plurality of fixed point markers (4) at defined sites, wherein the fixed point markers (4) store data that can be received by a mobile device (10) carried by a person (8);

an elevator control (32) through which a drive unit (34) can be controlled in order to move an elevator car (49) between floors (L1, L2, L3) of the building (2); and

a safety system (44) with a computer system (44a), wherein the safety sstem (44) is communicatively coupled to the elevator control (32) and wherein the computer system (44a) executes a software program that:

determines instantaneous positions of mobile devices (10) in the building (2), wherein an instantaneous position of a mobile device (10) is determined when the mobile device (10) uses data received from a first fixed point marker (4) to access a database (47) in which the data is linked to a site of the first fixed point marker (4);

determines a current traffic situation for each floor (L1, L2, L3) on the basis of the instantaneous positions of the mobile devices (10); and

determines a sequence of the floors (L1, L2, L3) to be evacuated on the basis of the current traffic situation on the floors (L1, L2, L3).

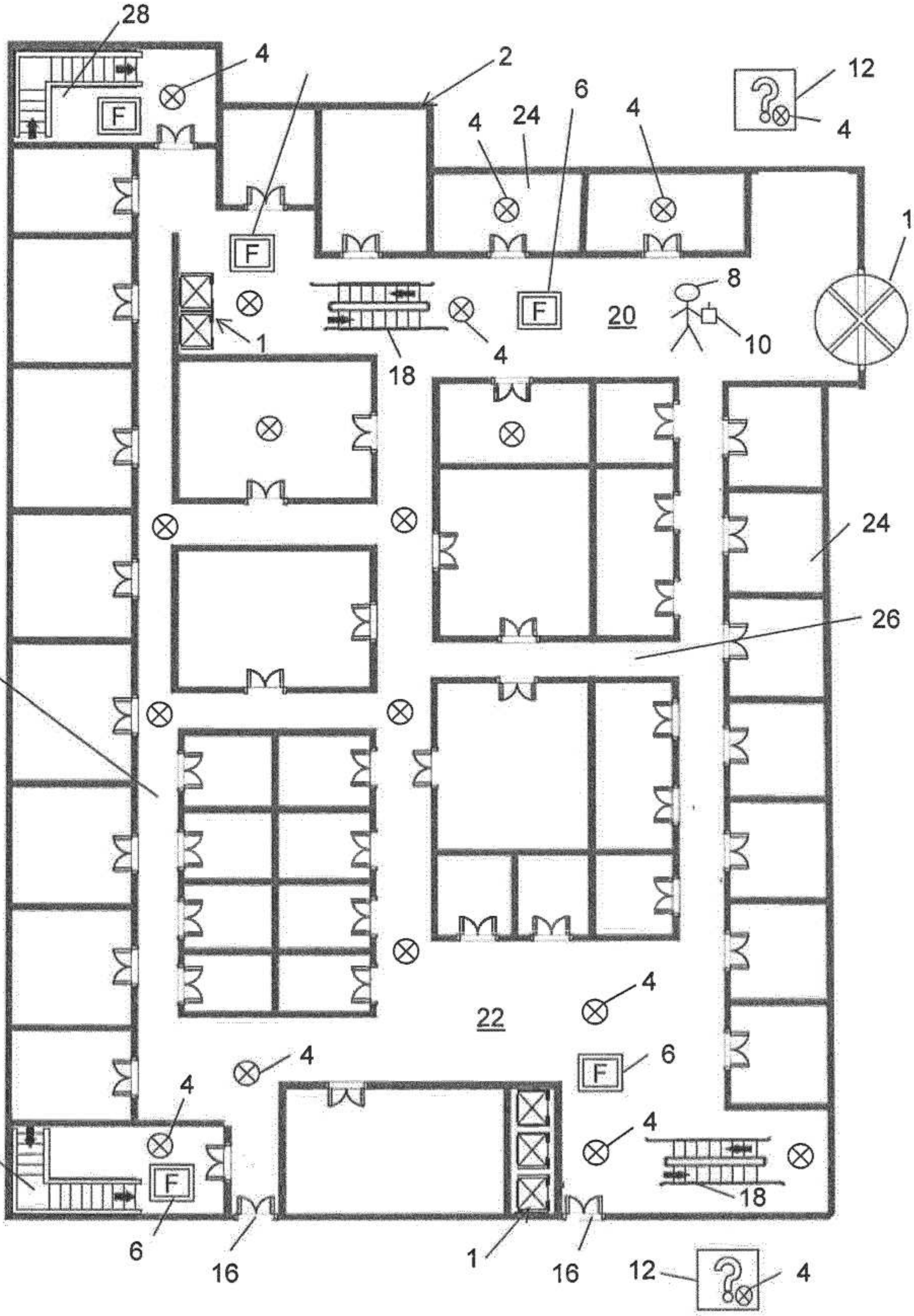
14. System according to claim 13, in which the software program also controls the elevator system (1) according to the determined sequence in order to move the elevator car (49) according to the sequence.

15. System according to claim 13 or 14, in which the software program also determines available escape routes for each mobile device (10) of which the instantaneous position has been determined to a destination (12) on the basis of the instantaneous position of the mobile device (10), and identifies instantaneous positions for which the available escape routes comprise using the elevator system (1), wherein the identified available escape routes are available for determining the sequence of the floors (L1, L2, L3) to be evacuated.

16. System according to any of claims 13-115, in which the software program also causes evacuation information to be sent to a mobile device (10) of which the instantaneous position has been determined, wherein the evacuation information is individual for the mobile device (10), and comprises instructions for a person (8) with

whom this mobile device (10) has been associated.

17. System according to any of claims 13-16, in which a fixed point marker (4) is arranged in an elevator car (49) of the elevator system (1).



28
4
2
12
6
4
24
4
4
14
F
F
8
F
20
1
10
18
4
24
26
26
22
4
4
6
F
28
4
4
F
18
6
16
1
16
12
4

Fig. 1

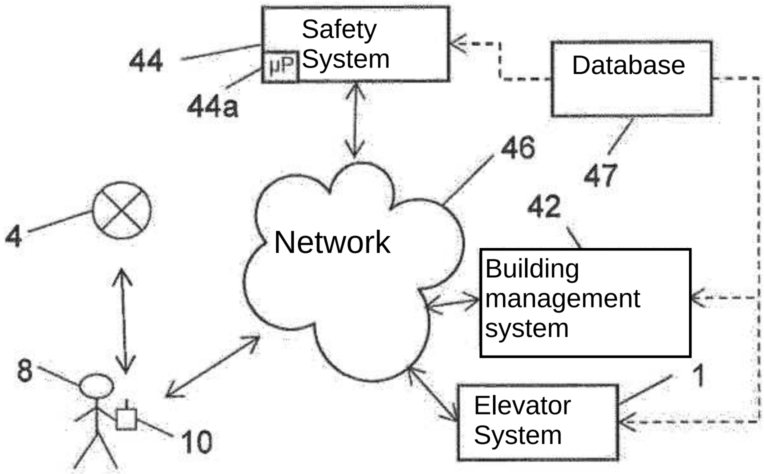

Safety System
μP
44
44a
Database
Network
46
47
42
4
Building management system
8
10
1
Elevator System

Fig. 2

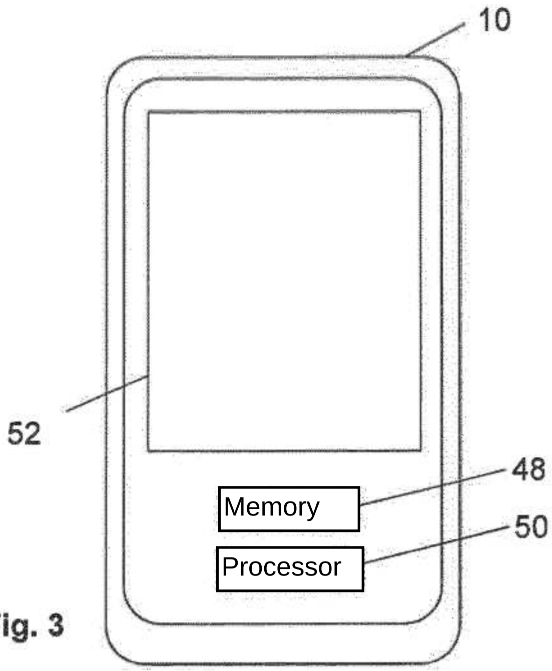

10
52
Memory
48
Processor
50

Fig. 3

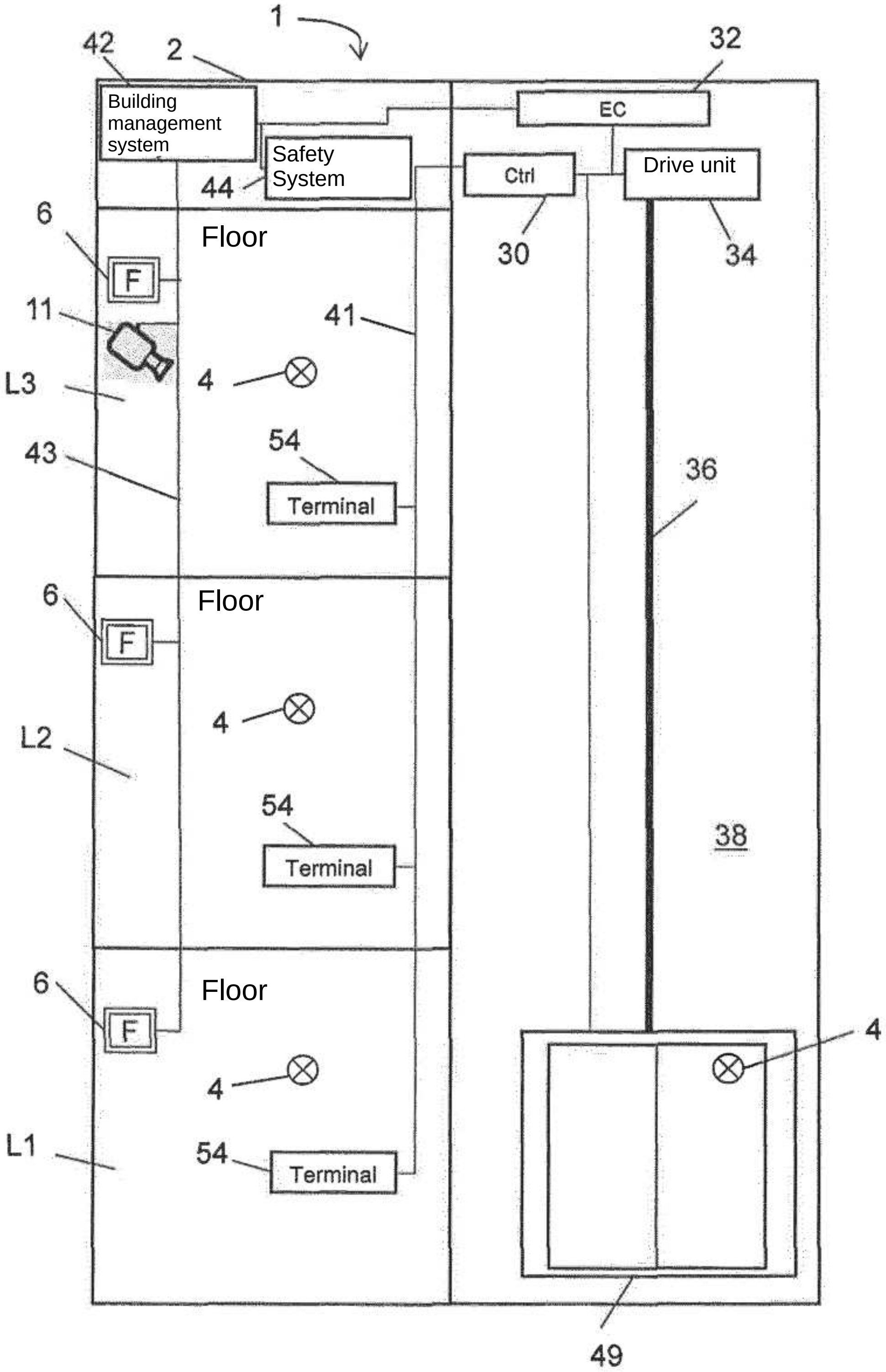

1
42
2
32
Building management system
EC
Safety System
Ctrl
Drive unit
44
6
Floor
30
34
F
11
41
L3
4
43
54
36
Terminal
6
Floor
F
4
L2
54
38
Terminal
6
Floor
F
4
4
L1
54
Terminal
49

Fig. 4

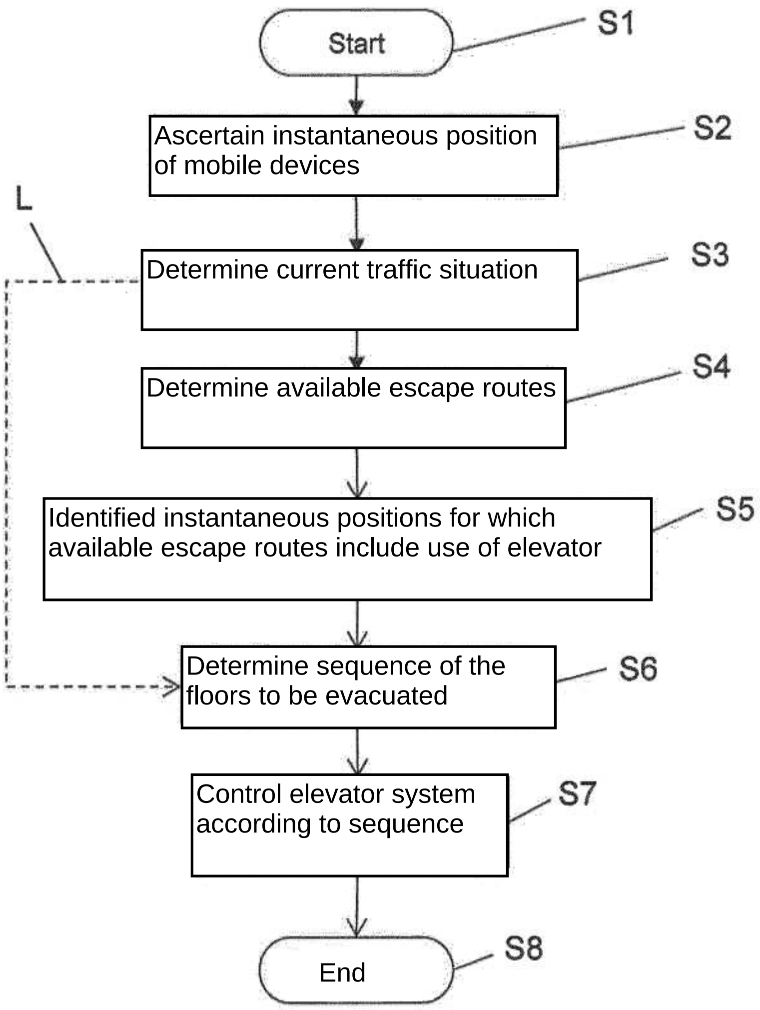

Start
S1
Ascertain instantaneous position of mobile devices
S2
L
Determine current traffic situation
S3
Determine available escape routes
S4
Identified instantaneous positions for which available escape routes include use of elevator
S5
Determine sequence of the floors to be evacuated
S6
Control elevator system according to sequence
S7
End
S8

Fig. 5