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(54) **METHOD OF RETROFITTING A SMOKE EXTRACTOR SYSTEM TO A BUILDING AND BUILDING RETROFITTED WITH SAID SMOKE EXTRACTOR SYSTEM**

(57) A method of retrofitting a smoke extractor system (12) to a building (14) having a plurality of storeys (16) interconnected by a lift shaft (54), the method comprising providing a mechanical ventilation device (18) to the lift shaft (54). The mechanical ventilation device (18) has an inlet (20) at or adjacent to the lift shaft (54) and an outlet (22) external to the building (14). The method further comprises providing a smoke access path (24) on each storey (16) which couples each storey (16) to the lift shaft (54) and the mechanical ventilation device (18), lift shaft (54) and smoke access path (24) defining a smoke extraction system (10) such that in the event (24) of smoke present on at least one of the plurality of storeys (16), there is a smoke escape pathway. The smoke escape pathway extending from the or each storey (16) through the associated smoke access path (24), via the lift shaft (54) and the mechanical ventilation device (18) to an exterior of the building (14), the mechanical ventilation device (18) providing an airflow through the smoke extraction system (10).

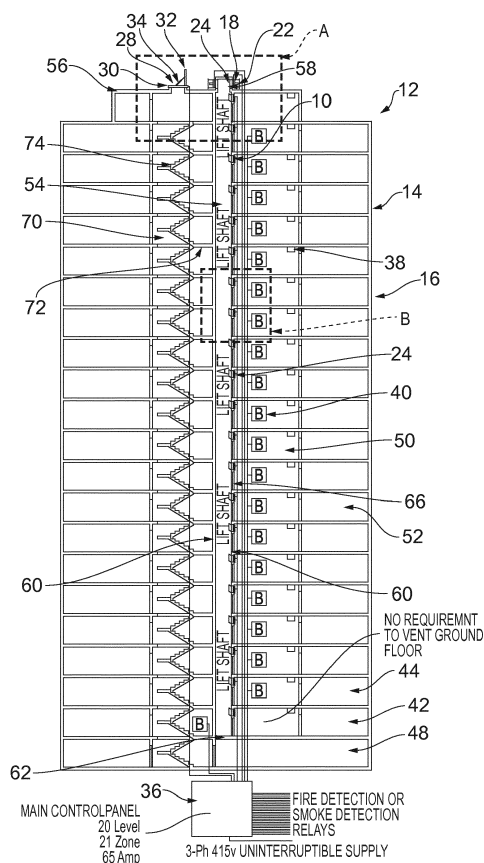


FIG. 1

Description

[0001] The present invention relates to a method of retrofitting a smoke extractor system to a building having a plurality of storeys, floors or levels. The invention further relates to a retrofittable apparatus and a system, both adapted for use the aforementioned method.

[0002] Buildings having a plurality of vertically-displaced storeys, known as high-rise buildings or tower blocks, are used for both residential and commercial contexts. High-rise buildings typically only have access available on the ground storey and therefore a fire in the building, especially one at a lower storey, can create hazard and danger to the occupants of the building, given the limited number of escape paths.

[0003] One of the greatest hazards generated by a fire in a building is that of smoke, the prolonged inhalation of which can result in long term respiratory problems or death. The hazard posed by smoke to occupants attempting to escape the building can be prevented, reduced or limited through ventilation of the building, so as to cause or allow smoke to leave the building and be replaced by fresh, smoke-free air. This need for ventilation especially applies to the communal access routes which conventionally form the only routes of escape.

[0004] However, in older high-rise buildings, for example those constructed between 1963 and 1972 in the UK and globally, in addition to some more modern high-rise buildings, communal access routes through the building, such as the stairwell and corridors connecting rooms within the flat to the stairwell, typically do not have, or have limited, means for ventilation. Additionally, given the typical layout of these buildings as having the majority of the communal access routes within the centre of the building, it is difficult to retrofit conventional ventilation means, such as openable windows, as the stairwell and corridors have limited boundaries with an exterior of the building, or smoke shafts which require an open void through each and every level of the building.

[0005] Therefore, in these older high-rise buildings, in the event of a fire incident in the building, once smoke has entered the communal access routes it typically does not dissipate sufficiently quickly and so poses a hazard to escaping occupants.

[0006] The present invention seeks to provide a solution to these problems.

[0007] According to a first aspect of the present invention, there is provided a method of retrofitting a smoke extractor system to a building having a plurality of storeys which are interconnected by a lift shaft, the method comprising the steps of: installing a mechanical ventilation device to the lift shaft, the mechanical ventilation device having an inlet at or adjacent to the lift shaft and an outlet external to the building; and providing a smoke access path on each storey which couples each storey to the lift shaft and providing a smoke detector on each of the plurality of storeys; installing a controller for activating the mechanical ventilation device and opening and/or closing

at least one of the smoke access paths; providing a first air access path between the stairwell and the exterior of the building comprising an automatically opening vent, openable by the controller; providing a second air access path between the stairwell and the lift shaft; the mechanical ventilation device, lift shaft and smoke access path defining a smoke extraction system such that in the event of smoke being detected by a said smoke detector on at least one of the plurality of storeys, there is a smoke escape pathway from the or each storey through the associated smoke access path, via the lift shaft and the mechanical ventilation device to an exterior of the building, the mechanical ventilation device providing an airflow through the smoke extraction system; wherein there is an air access pathway from the exterior of the building through the first air access path, via the stairwell, the second air access path, the lift shaft and the mechanical ventilation device to the exterior of the building, the mechanical ventilation device providing an airflow through the air access pathway.

[0008] This method allows for a smoke extractor system to be retrofitted to a building where a majority of the communal areas of the building are not adjacent to the exterior of the building. As lift shafts are typically formed as an axially extending conduit through the building intersecting each storey and being adjacent to the exterior of the building at an upper portion of the lift shaft, they represent a suitable pathway for extracting smoke from a building. The smoke pathway allows for smoke to be ventilated from the building and therefore prevent, limit or reduce the risk of smoke inhalation by escaping occupants of the building.

[0009] Preferably, each smoke access path may be open or openable. Optionally, the smoke access path may have a damper valve. Beneficially, each smoke access path is only open in the event of smoke being present on the associated storey. Providing for each smoke access path to be open or openable allows for smoke to move from the communal access area of each storey where it may be present to the lift shaft, thus reducing the risk of smoke inhalation to those in the communal access corridor. The smoke access path having a damper valve may allow for the smoke access path to be set interchangeably to either to the open condition, and so provide the benefits as previously described, or to the closed condition and thus prevent or limit smoke which may be present in the lift shaft from entering the storey where the smoke is not present. In this way smoke can be prevented or limited from spreading or infiltrating to other storeys and so occupants of the building present on those storeys can be at a lower risk of smoke inhalation.

[0010] Alternatively, the smoke access path is a lift-shaft door. This allows for the smoke extractor system to be retrofitted to a building in a more cost-efficient manner as vents may not have to be specifically installed. The lift-shaft door of a storey may be at least partially opened when smoke is present on the storey and closed

when smoke is not present on the storey and thereby provide and openable and/or closable smoke access path.

[0011] The controller allows for the remote and/or automatic operation and/or activation of the smoke extractor system.

[0012] The smoke detector allows for the automatic detection of smoke and thus permit the automatic operation and/or activation of the smoke extractor system.

[0013] Preferably, the method may further comprise the step of an associated lift car of the lift shaft being driven at or adjacent to a ground storey of the building in the event of smoke being detected. The positioning of the lift car at or adjacent to the ground storey of the building results in a majority of the lift shaft being unobstructed and thus is a more effective path for the movement of smoke.

[0014] Additionally, the method may further comprise the step of providing sealant between the lift shaft and the plurality of storeys. The provision of sealant reduces or restricts the number of smoke leakage paths that may exist between the lift shaft and the plurality of storeys. This may prevent or limit smoke present in the lift shaft from accessing the or each storey which does not have smoke present.

[0015] The provision of a second air access path in a stairwell allows for smoke which may have spread to the stairwell to escape from the stairwell to the exterior of the building. Additionally or alternatively, the second air access pathway allows for air and to be moved or drawn from the exterior of the building, through the first air access path and at least part of the stairwell and to the lift shaft. This thereby provides a supply of air along at least part of the stairwell and so may prevent or limit the escaping occupants of the building from inhaling smoke.

[0016] In a preferable embodiment, the first air access path is open or openable. The first air access path being open or openable allows for any smoke to leave from the stairwell and being an automatically opening vent, which may be closed when smoke is not detected, may prevent rain, for example, from entering the building when the smoke extractor system is not in use.

[0017] Preferably, the method may further comprise the step of installing a lift-shaft-modification apparatus to the lift shaft, in order that the lift shaft can act as a pressurised smoke shaft. The lift-shaft-modification apparatus may comprise any or all of: mechanical lifting equipment; lift car; guide rails; wiring; lift controller; pulleys; cables; tracks; and counterweights. Furthermore, the lift-shaft-modification apparatus may comprise at least one restraining device for restraining movable components within the lift shaft upon activation of the smoke extraction system.

[0018] The provision of lift-shaft-modification apparatus may advantageously allow older-style lift shafts to be retrofitted with a smoke extraction system. The lift shaft needs to be able to act as a pressurised smoke shaft for the building, and the existing lift cab and lifting mecha-

nisms may not be suitable for this purpose. There may be leak pathways present into the various storeys of the building which could retard the smoke extraction effectiveness of the mechanical ventilation device in use. The lift-shaft-modification apparatus can serve to prevent these leakages, and also improve the smoke extraction efficiency of the retrofitted lift shaft.

[0019] Preferably, the lift shaft further comprises a machine room having a barrier between the machine room and the remainder of the lift shaft and the mechanical ventilation device being installed with the inlet adjacent to the machine room. Advantageously at least one smoke access aperture is formed through the barrier to provide a smoke pathway between the machine room and the remainder of the lift shaft. If a barrier is present between the machine room and the remainder of the lift shaft, smoke may be prevented from exiting the lift shaft. In this instance, at least one aperture may be formed through the barrier such that smoke is able to move from the lift shaft to the machine room, and from there escape from the building.

[0020] According to a second aspect of the invention there is provided a retrofittable apparatus adapted for retro-installation of a smoke extractor system to a building having a plurality of stories and a lift shaft, the apparatus comprising: at least one mechanical ventilation device having an inlet and an outlet for the extraction of smoke from the lift shaft to the exterior of the building; and at least one vent for providing a smoke access path between the lift shaft and each of the storeys.

[0021] Preferably, each vent may have a damper valve.

[0022] Advantageously, the retrofittable apparatus may further comprise a controller for activating the or each mechanical ventilation device and controlling at least one of the damper valves.

[0023] Beneficially, the retrofittable apparatus may further comprise at least one smoke detector.

[0024] In a preferable embodiment, the retrofittable apparatus may further comprise an automatically opening vent in addition to the plurality of vents.

[0025] The retrofittable apparatus may preferably further comprise a lift-shaft-modification apparatus to the lift shaft, in order that the lift shaft can act as a pressurised smoke shaft. The lift-shaft-modification apparatus may comprise any or all of: mechanical lifting equipment; lift car; guide rails; wiring; lift controller; pulleys; cables; tracks; and counterweights. Furthermore, the lift-shaft-modification apparatus may comprise at least one restraining device for restraining movable components within the lift shaft upon activation of the smoke extraction system.

[0026] The lift-shaft-modification apparatus beneficially serves to improve the smoke extraction efficiency of the lift shaft, if applied correctly to the lift shaft.

[0027] According to a third aspect of the present invention there is provided a building having a retrofittable apparatus in accordance with the second aspect of the in-

vention to form a smoke extraction system, the building comprising: a plurality of storeys; a lift shaft which interconnects the plurality of storeys; the inlet of the mechanical ventilation device being at or adjacent to the lift shaft and the outlet being external to the building; and the at least one vent being positioned between the lift shaft and each storey.

[0028] Preferably, the building may further comprise a stairwell.

[0029] Advantageously, the building may further comprise a first air access path positioned between the exterior of the building and the stairwell.

[0030] Beneficially, the building may further comprise a second air access path positioned between the stairwell and the lift shaft.

[0031] In a preferable embodiment, the building may further comprise a controller for activating the or each mechanical ventilation device, opening at least one of the vents and opening the first air access path.

[0032] Additionally, the building may further comprise a smoke detector positioned on each of the plurality of storeys and operatively connected to the controller.

[0033] According to a fourth aspect of the present invention, there is provided a building having a retrofitted smoke extraction system, the building comprising: a lift shaft; a plurality of storeys which are interconnected by the lift shaft; a smoke detector on each of the plurality of storeys; a controller for activating the mechanical ventilation device and opening and/or closing at least one of the smoke access paths; a first air access path between the stairwell and the exterior of the building comprising an automatically opening vent, openable by the controller; a second air access path between the stairwell and the lift shaft; a mechanical ventilation device on the lift shaft, the mechanical ventilation device having an inlet at or adjacent to the lift shaft and an outlet external to the building; a smoke access path on each storey which couples each storey to the lift shaft; and the mechanical ventilation device, lift shaft and smoke access path defining a smoke extraction system such that in the event of smoke being detected by a said smoke detector on at least one of the plurality of storeys, there is a smoke escape pathway from the or each storey through the associated smoke access path, via the lift shaft and the mechanical ventilation device to an exterior of the building, the mechanical ventilation device providing an airflow through the smoke extraction system; wherein there is an air access pathway from the exterior of the building through the first air access path, via the stairwell, the second air access path, the lift shaft and the mechanical ventilation device to the exterior of the building, the mechanical ventilation device providing an airflow through the air access pathway.

[0034] According to a fifth aspect of the present invention, there is provided a method of retrofitting a smoke extractor system to a building having a plurality of storeys which are interconnected by a lift shaft, the method comprising the steps of: installing a mechanical ventilation

device to the lift shaft, the mechanical ventilation device having an inlet at or adjacent to the lift shaft and an outlet external to the building; and providing a smoke access path on each storey which couples each storey to the lift shaft; the mechanical ventilation device, lift shaft and smoke access path defining a smoke extraction system such that in the event of smoke present on at least one of the plurality of storeys, there is a smoke escape pathway from the or each storey through the associated smoke access path, via the lift shaft and the mechanical ventilation device to an exterior of the building, the mechanical ventilation device providing an airflow through the smoke extraction system.

[0035] The invention will now be more particularly described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a side representation of a longitudinal cross section of an embodiment of a system in accordance with the third aspect of the present invention, specifically adapted to the method in accordance with the first aspect of the present invention and having been installed using an apparatus in accordance with the second aspect of the present invention;

Figure 2 shows an enlarged representation of the area within box A of Figure 1;

Figure 3 shows an enlarged representation of the area within box B of Figure 1; and

Figure 4 shows a view of box B of Figures 1 and 3, as viewed from a corridor of the storey.

[0036] Referring to Figures 1 to 4, there is shown a retrofittable apparatus 10 installed on a building 14 to form a smoke extractor system 12. The building 14 is a high-rise building and thereby has a plurality of storeys, floors, levels or tiers 16.

[0037] Smoke is herein defined as a suspension of particles, which may be carbon based, in air and/or a variety of gases which may include, but are not limited to, carbon dioxide, carbon monoxide, nitrogen oxides and sulphur oxides which are the result of combustion. The present invention could thereby also be considered for the use of toxic gas extraction.

[0038] The retrofittable apparatus 10 comprises at least one mechanical ventilation device 18 having an inlet 20 and an outlet 22. The mechanical ventilation device 18 may here be or have an extractor fan however may alternatively be or have an air pump or any other means for providing ventilation. Although two mechanical ventilation devices 18 are shown in Figure 1 any other number of mechanical ventilation devices may be provided. It is preferred that there are at least two, with a first mechanical ventilation device acting as a duty unit, with the or each further mechanical ventilation device acting as

stand-by units in the event of failure of the duty unit.

[0039] The retrofittable apparatus 10 further comprises a plurality of vents 24 which may have or take the form of conduits. Each conduit may be considered to be an elongate tube or tubing, having a rectangular or circular lateral cross-section and in use is for providing a path through a wall of a building, such as between a lift shaft and a storey. Here, each vent 24 may preferably have an open and a closed condition and may therefore be or have a damper valve, having at least one blade 26 pivotably received across a lateral extent of the conduit. The or each blade 26 may preferably be or be substantially in the shape of a strip and therefore may be or be substantially planar. Here, the or each blade 26 thereby has two planar faces separated by four edge portions and may be pivotable between a closed and an open position. When in the closed position the or each blade 26 may be orientated such that the planar faces are or are substantially aligned with the path of the conduit and thus occlude or substantially occlude the conduit. In the event of more than one blade 26 this may be achieved by a portion of each of the blades 26 being aligned or overlapping with each other. This may preferably create an air tight seal. When in the open condition the or each blade 26 may preferably be orientated such that an edge portion of the blade 26 is aligned with the path of the vent 24, thus creating a smoke escape path through the vent 24.

[0040] The vent 24 may further comprise a, preferably electric, motor operatively connected to the or each of the blades 26 so as to pivot the blades 26 from the closed to the open condition or vice versa. Hydraulic actuators could be considered as an alternative, and other arrangements will be apparent to the skilled person. The vents 24 may therefore be openable and/or closable. Alternatively or additionally, there may be a manually operable handle, lever, switch or slider operatively connected to blades 26 so as to pivot the blades 26 from the open to the closed position or vice versa.

[0041] Although the vent 24 is described as being or having a damper valve, it is appreciated that the closable vent 24 may in fact have any kind of valve capable of restricting the flow of smoke through the conduit. Additionally, although the vent 24 is described as having an open and closed condition it is appreciated that the vent 24 may in fact not have a closed condition and may have a permanent path through the conduit for example, being formed as or having a ventilation grille.

[0042] The retrofittable apparatus 10 may additionally comprise an automatically opening vent 28 which may have a frame 30 and an openable element 32 pivotably attached to the frame 30. The openable element 32 may be pivotable between a closed position, where the openable element 32 may be or be substantially aligned and/or coplanar with the frame 30, and an open position, where the openable element 32 may not be or be substantially aligned and/or coplanar with the frame 30. The automatically opening vent 28 may additionally have an actuator

34 to move the openable element 32 from the closed to the open position.

[0043] Optionally, the retrofittable apparatus 10 may comprise at least one further vent, in use for providing a second air access path between a stairwell and a lift shaft. The further vent may be openable and/or closable and thus may be or have a damper valve having an electric motor to facilitate opening/closing. However, it is appreciated that the further vent may not be openable and/or closable and therefore may only be a conduit.

[0044] The retrofittable apparatus 10 may preferably further comprise at least one controller 36, which may in use be operatively, and preferably electrically, connectable to the electric motor of the or each openable vent 24 or damper valve. This connection may be such that, in the event of a plurality of openable vents 24, each openable vent 24 is able to be openable independent from the others. The or each controller 36 or a further controller may be similarly connected to the mechanical ventilation device 18 to trigger the activation of the mechanical ventilation device 18. Similarly, the or each controller 36 or a further controller may be operatively connected to the automatically opening vent 28 to trigger the movement of the actuator 34 and the opening of the automatically opening vent 28. This opening, triggering and/or activation is preferably automatic however may alternatively require the interaction of a person with the controller 36.

[0045] The retrofittable apparatus 10 may preferably also include at least one smoke detector 38 which may be operatively connected to the or each controller 36. There may preferably be a smoke detector 38 for each of the openable vents 24. Each smoke detector 38 may preferably be operatively connected to the or each controller 36, or alternatively, directly connected to the associated openable vent 24.

[0046] At least one smoke seal or intumescent strip may also be included within the retrofittable apparatus 10.

[0047] A manual override switch 40 for specific storeys may be included in the retrofittable apparatus which, when operated, may either activate or deactivate the smoke extractor system 12.

[0048] In use, the apparatus 16 may be retrofitted to a building 14, which may preferably be a high-rise building 14, to provide a smoke extractor system 12 to the building 14.

[0049] As shown in the figures, the building 14 here has a ground storey 42 and twenty exemplary upper storeys 44 vertically displaced from and aligned with one another and with the ground storey 42. There is additionally a basement storey 48 positioned below ground level and/or below the ground storey 42. Each storey 16 is here comprised of a communal access corridor 50 and at least one room 52, the or each room 52 having an opening to the communal access corridor 50.

[0050] Although the building 14 is described as having a total of twenty-two storeys 16, it is appreciated that

there may in fact be any number of storeys 16 greater than one. It is further appreciated that there may not be a basement storey 48, that there may be more than one basement storey 48 and/or that all storeys 16 may be positioned below the ground level. Furthermore, although the building 14 is shown as having storeys 16 which are aligned with each other and having a similar plan, it is appreciated that the storeys 16 may be laterally and/or vertically displaced from one another and/or have differing plans. Whilst the layout of each storey 16 is described as having a communal access corridor 50, it is appreciated that there may in fact not be a communal access corridor 50 and each storey 16 may only be comprised of at least one room 52.

[0051] An in use lift shaft 54 may extend through a longitudinal or vertical extent of the building 14 and is here positioned at, adjacent to or engaging each of the plurality of storeys 16. The lift shaft 54 preferably engages the communal access corridor 50 of each storey 16. The lift shaft 54 may extend from or adjacent from the ground level storey 16 to or adjacent to the uppermost storey 16, and here extends beyond the uppermost storey 16 such that the lift shaft 54 projects from a roof 56 or uppermost surface of the building 14. This projection from the roof 56 of the building 14 is here described as a lift overrun 58. The lift shaft 54 therefore here intersects each of the plurality of stories, with the exception of the basement story. Although the lift shaft 54 here is at or adjacent to and engages each of the plurality of storeys 16 it is appreciated that it may not in fact engage all of the storeys 16 of the building 14.

[0052] The lift shaft 54 here is positioned axially centrally with respect to the building 14 and may have a or a substantially rectangular plan. The longitudinal walls 60 of the lift shaft 54 are contiguous with each other and the bottom of the lift shaft 54 engages a floor 62 of the ground storey 42. The lift overrun 58 may have a plurality of contiguous walls 64 upstanding from the roof 56 and have a lift shaft roof engaging an upper surface of each of the walls 64. In this way, the lift shaft 54 may have a series of contiguous walls such that it represents a or a substantially contained chamber.

[0053] The lift shaft 54 may additionally comprise a machine room, cavity or space positioned above the lift overrun for the storing and/or positioning of components to operate a lift car. A barrier may be between the machine room and the remainder of the lift shaft 54. This barrier may here take the form of a concrete slab or wall.

[0054] At each storey 16 the lift shaft 54 may have an opening which may be closable or occludable by a lift-shaft door 66. Each lift-shaft door 66 may here take the form of two slidable door members 68 which are receivable within the wall 60 which separates the lift shaft 54 from the remainder of the associated storey 16. When the door members 68 are received within the wall the lift-shaft door 66 is in an open condition. When the door members 68 engage each other and each edge of the opening such that the lift shaft opening is occluded the

lift-shaft door 66 is in a closed condition. Although the lift-shaft door 66 is described as having two slidable door members 68, it is appreciated that the lift-shaft door may in fact have only a single slidable door member

[0055] A lift car may be received within the lift shaft 54 and may be movable along the longitudinal or vertical extent of the lift shaft 54.

[0056] A stairwell 70 may extend through a longitudinal or vertical extent of the building 14 and is here positioned at or adjacent to, and engages, each the plurality of storeys 16. The stairwell 70 may extend from or adjacent from the floor of the basement storey 48 to or adjacent to the upper surface of the uppermost storey 16 or to the roof 56. Within the stairwell 70 there may be a landing 72 at each storey 16 and a staircase 74 interconnecting each landing 72. The extent of the stairwell 70 may preferably be continuous and unbroken and as such the landing 72 may preferably not extend across the whole of the lateral extent of stairwell 70.

[0057] In use, to retrofit the retrofittable apparatus 10 to the building 14, the or each mechanical ventilation device 18 is installed to the lift shaft 54. The or each mechanical ventilation device 18 is preferably installed to, at or adjacent to the lift overrun 58 with the inlet 20 of each mechanical ventilation device 18 being positioned within the lift shaft 54, and here within the lift overrun 58, and an outlet 22 being positioned external to the building 14, and here adjacent to an external surface of the lift overrun 58. Here two mechanical ventilation devices 18 are installed, each mechanical ventilation device 18 being in opposing walls 64 of the lift overrun 58. The or each mechanical ventilation device 18 is preferably connected to a power supply which may be the grid and/or a backup battery supply.

[0058] Although two mechanical ventilation devices 18 are here retrofitted to the building 14, it is appreciated that any number of mechanical ventilation devices 18 may be retrofitted, such as one, or more than two. It is additionally appreciated that the or each mechanical ventilation device 18 may be positioned at an upper surface of the lift overrun 58, rather than on the walls 64. Additionally or alternatively, the or each mechanical ventilation device 18 may be installed at or adjacent to other portions of the lift shaft 54, for example at or adjacent to the ground storey 42 or, in the event that the lift shaft 54 extends adjacent to the exterior of the building 14, at or adjacent to any storey 16 of the building 14. Furthermore, mechanical ventilation devices 18 may be considered which have an inlet 20 at or adjacent to any of the storeys 16 not adjacent to the exterior of the building 14 and an outlet 22 at the exterior of the building 14 adjacent to a longitudinal extent of the building 14 and in this way may have an extended elongate conduit through a lateral extent of the building 14.

[0059] A smoke access path 24 may be provided between each storey 16, and as illustrated only those storeys 16 above the ground storey 42, and the lift shaft 54. The smoke access path 24 may take the form of an ap-

erture in the wall 60 between the lift shaft 54 and a communal access corridor 50 of the associated storey 16. The aperture may be formed in the wall 60 through drilling, for example using a diamond core drill bit; cutting, for example using a diamond cutting disc or diamond chain saw; breaking out, for example by hand using a hammer and chisel or with a pneumatic hammer; with a thermal lance, boring or hammering such that there is a continuous path through the wall. Preferably, a conduit, may be positioned within this aperture and the aperture is sized such that the conduit is or is substantially engageably received within the aperture such that there is no path around the outside of the conduit. A damper valve may be fitted to the conduit and the combination between the aperture, conduit and/or damper valve may form the vent 24 and smoke access path 24. Here the smoke access path 24 is provided above the lift-shaft door 66, however it is appreciated that the smoke access path 24 may in fact be provided anywhere between the communal access corridor 50 and the lift shaft 54 or alternatively between anywhere within the storey 16 and the lift shaft 54. The electric motor of each vent 24 is preferably connected to a power supply which may be the grid and/or a backup battery supply.

[0060] Although a smoke access path 24 is shown to be fitted to each of the storeys 16 above the ground storey 42, it is appreciated that a smoke access path 24 may in fact not be fitted to each of the storeys 16 and thus may only be fitted to a selection of stories. Additionally, it is appreciated a smoke access path 24 may be fitted to the ground storey 42 and/or the basement storey 48.

[0061] In the event a machine room or similar is positioned above the lift shaft 54 and the mechanical ventilation device is installed such that the inlet is at, adjacent to or in the machine room, at least one smoke access aperture may be formed through the barrier to provide, maintain or contribute to the smoke access path 24. This formation may take the form of drilling, for example using a diamond core drill bit; cutting, for example using a diamond cutting disc or diamond chain saw; breaking out, for example by hand using a hammer and chisel or with a pneumatic hammer; with a thermal lance, boring or hammering through the concrete slab which may make up the barrier.

[0062] The combination of the mechanical ventilation device 18, the lift shaft 54 and the smoke access path 24 between each storey 16 and the lift shaft 54 may in use thereby define a smoke escape pathway as well as the smoke extractor system 12. The mechanical ventilation device 18 in use causes a flow of air and/or smoke through the smoke escape pathway, from a communal access corridor or other location on the storey 16 where fire may be present to the exterior of the building.

[0063] The retrofittable apparatus 10 could also be provided with additional components, collectively considered to be a lift-shaft-modification apparatus which can improve the smoke extraction efficiency of the lift shaft, to make it better suited to acting as a pressurized smoke

shaft. This could include replacement or modified mechanical lifting equipment, lift car, guide rails, wiring, lift controller, pulleys, cables, tracks, and/or counterweights, by way of example, which could be installed to the lift shaft in order to eliminate leak pathways for smoke within the lift shaft, whilst the smoke extraction system is in operation.

[0064] Furthermore, it may be possible to provide one or more restraints, which could be used to secure or tether some of the movable components within the lift shaft, such that the movable components remain in place when the mechanical ventilation device 18 is operational. The restraints would be intended to prevent any inhibition of smoke extraction performance during operation of the mechanical ventilation device 18.

[0065] A first air access path 28 is preferably defined between the stairwell 70 and the exterior of the building 14. Here the air access path 28 is preferably defined at, adjacent to or in the upper surface of the uppermost storey 16 of the stairwell 70 and may take the form of an aperture through the roof 56. The automatically opening vent 28 may preferably be installed or positioned through, at or in the aperture, and the aperture may be sized so that the automatically opening vent 28 engages each of the edges of the aperture. The actuator 34 of the automatically opening vent 28 may be connected to a power supply which may be the grid and/or a backup battery supply.

[0066] Optionally, a second air access path may be provided between the stairwell 70 and the lift shaft 54. This second air access path may be defined as at least one aperture between the wall separating the stairwell 70 and the lift shaft 54. Within the or each aperture the further vent, which may comprise a conduit and/or a damper valve and thus be openable and/or closable, may be installed. The second air access pathway may be positioned at, adjacent to or proximal to the ground storey 42 of the building 14; however, the second air access path may alternatively be positioned anywhere between the lift shaft 54 and the stairwell 70. Alternatively, the second air access path may be the result of air leakage paths between the stairwell 70 and the lift shaft 54 and may not be purposefully installed during the retrofitting process.

[0067] The combination of the mechanical ventilation device 18, the lift shaft 54, the first air access path 24, the stairwell 70 may in use thereby define a clean air access pathway. The mechanical ventilation device 18 in use causes a flow of air through the clean air access pathway, from the exterior of the building 16 and through the stairwell 70.

[0068] The or each controller 36 may be installed to the building 14. Here there is a single controller 36 which is preferably operatively connected to the mechanical ventilation device 18, the electric motor of each vent 24, including the further vent of the second air access path if present, the automatically opening vent 28 and the lift car.

[0069] At least one smoke detector 38 is preferably installed on each of the storeys 16 of the building 14. Each smoke detector 38 may be connected to the or each controller 36 in such a way so as to send a signal from each smoke detector 38 to the controller 36. Although a smoke detector 38 for each storey 16 is described, it is appreciated that a smoke detector 38 may only be installed on a selection of stories.

[0070] The lift shaft 54 may be sealed so as to prevent or limit in use smoke, which may be within the lift shaft 54, from seeping, moving or infiltrating to stories where smoke is not present. Additionally, the sealing may be used to prevent or limit fire from spreading from a storey 16 to the lift shaft 54 or vice versa. This sealing may take the form of retrofitting smoke seals or intumescent strips around the lift-shaft doors 66 or to any other aperture between the lift shaft 54 and the stair well.

[0071] In use, in the event that smoke, which may be caused by a fire, is present on a storey 16 of the building 14, the smoke detector 38 which may be positioned on said storey 16, detects the smoke and a signal is sent to the controller 36. The controller 36 may send a signal to the lift car, the signal causing the lift car to immediately travel to or adjacent to the portion of lift shaft 54 at or adjacent to the ground storey 42. In this way, there is an unobstructed path from the mechanical ventilation device 18 along a majority of the lift shaft 54.

[0072] If the vent 24, or smoke access path, between the lift shaft 54 and the or each storey 16 having smoke therein has the form of a damper valve having an electric motor, a signal is sent from the controller 36 to the electric motor and the damper valve is set to the open condition. A signal may also be sent to the electric motor of each of the vents 24 on storeys 16 where smoke is not present and the damper valve set to the closed condition. In the event that the damper valve of each storey 16 is in a closed condition when smoke is not detected in the building 14, then the damper valve on the smoke storey 16 is required to be opened and the damper valve on each of the storeys 16 where smoke is not present is not required to be closed. Alternatively, in the event that the damper valve of each storey 16 is in an open condition when smoke is not detected in the building 14, then the damper valve on the smoke storey 16 is not required to be opened and the damper valve on the storeys 16 where smoke is not detected is required to be closed.

[0073] If the controller 36 and/or the signalling system between the controller 36 and the vents 24 is damaged, malfunctions or is otherwise compromised such that damper valve is set to the open condition when it should be set to the closed condition or vice versa, the manually operable handle may be used. This may take the form of an occupant of the building 14, firefighter or other rescue personnel operating the manually operable handle, either allowing smoke to leave the storey 16 or preventing smoke from entering the storey 16.

[0074] In the event that smoke is present on a storey 16 where smoke was previously not present, the asso-

ciated smoke detector 38 may detect the smoke, a signal may be sent to the controller 36 and the associated vent 24 may be opened.

[0075] Simultaneously with the initial detection of smoke and the opening of the vent 24 of the or each smoke storey 16, a signal may be sent from the controller 36 to activate the mechanical ventilation device 18. The mechanical ventilation device 18, which may be or have an extractor fan, having an inlet 20 within the lift shaft 54 and an outlet 22 exterior to the lift shaft 54 and building 14 may cause a lowering of the pressure within the lift shaft 54 through the extraction of air and/or smoke from within the shaft.

[0076] At the same time as the mechanical ventilation device 18 is activated, the controller 36 may send a signal to the first air access path 28, which may be an automatically opening vent 28 having an actuator 34. The actuator 34 may be activated so as to cause an opening of the automatically opening vent 28 and thus an air access path between the exterior of the building 14 and the stair well is created.

[0077] The second air access pathway, which may take the form of at least one vent 24, may also be opened in the event that the second air access pathway is openable and/or closable.

[0078] In use, the override switch 40 may be operated to manually either activate or deactivate the smoke extractor system 12.

[0079] The lowering of the pressure within the lift shaft 54 by the mechanical ventilation device 18 may have the effect that the pressure is lower within the lift shaft 54 than within each of the storeys 16. In the event that the smoke access path 24 is open between a storey 16 and the lift shaft 54, this pressure differential or gradient creates a driving force for the smoke and/or air within the storey 16 to be extracted to the lift shaft 54. From here, the smoke may be moved upwards along a longitudinal or vertical extent of the lift shaft 54 and extracted via the inlet 20 and outlet 22 of the mechanical ventilation device 18 and out of the lift shaft 54 and building 14 to the exterior of the building 14. This therefore creates a smoke escape pathway. The movement of the smoke up along the lift shaft 54 may be the result of the lower pressure proximal to the inlet 20 of the mechanical ventilation device 18 as well as the buoyancy effect generated by the smoke being warmer than the ambient air temperature within the building 14. This removal of smoke from the or each smoke storey 16, and thus from the communal areas of each storey 16, may help to prevent cases of smoke inhalation among occupants of the building 14.

[0080] The positioning of the damper valve of the smoke escape path in a closed condition on a storey 16 where smoke is not present can prevent or limit the movement, spreading or infiltration of smoke, which may be present in the lift shaft 54, to a storey 16 where smoke is not already present. In the instance where a damper valve is not present within the vent 24, the differential between the pressure of the lift shaft 54 and each storey

16 may be such that smoke is prevented limited from moving, spreading or infiltrating to the or each storey 16 where smoke is not present.

[0081] The first air access path 28 being opened allows for any smoke which may have entered the stairwell 70 from any of the storeys 16 to exit from the stairwell 70 and the building 14. This movement of smoke may be caused by the buoyancy effect in the similar way as described for the smoke in the lift shaft 54.

[0082] Additionally or alternatively, given that there may be at least one second air access path between the stairwell 70 and the lift shaft 54, and due to the lower pressure within the lift shaft 54 as compared to the remainder of the building 14, there may be movement of smoke and/or air from the stairwell 70, through the or each second air access path, and to the lift shaft 54. This may cause a lowering of the pressure within the stairwell 70 as compared to the pressure exterior to the building 14. In this way, clean air may be caused to enter the stairwell 70 from the exterior of the building 14 and via the first air access path 28. Therefore, there may be clean air pathway from the exterior of the building 14, through the automatically opening vent 28 which may be the first air access path 28, through the stairwell 70 and to the lift shaft 54 via the second air access path. In the instance that the second air access path is positioned only at, adjacent to or proximal to the ground storey 42 of the building 14, there may therefore be a supply or movement of clean air from the exterior of the building 14 and through a majority of the stairwell 70. This clean air may help to prevent or limit escaping occupants of the building 14 from suffering from smoke inhalation.

[0083] Whilst a smoke detector 38 is described as detecting the presence of smoke and then triggering or activating the smoke extractor system 12, it is appreciated that the system 12 may alternatively have a heat detector or sensor such as a thermocouple positioned on each storey 16 which may detect heat on a storey 16 and then activate the smoke extractor system 12 in the same or similar way as previously described. Additionally or alternatively, the smoke extractor system 12 may be activated by a manual fire alarm activation device such as a pull station, which may be positioned on each of the storeys 16. If a pull station is triggered on a storey 16 then the smoke extractor system 12 may be activated in the same way as previously described.

[0084] Whilst a vent 24 such as a damper valve is described as providing the smoke access path 24, it is appreciated that the air access path may be provided by alternative means. For example, in the event of smoke being detected on a storey 16, the lift-shaft door 66 of that storey 16 may be partially or fully opened. The door 66 may be only partially opened, and as such the door members 68 may not engage one another however may also not be fully received within the wall, such that an occupant of the building 14 escaping the storey 16 may not mistakenly fall through the lift shaft opening and into the lift shaft 54. In this way, any opening of the lift-shaft

doors 66 may be limited to the width or breadth of a typical person.

[0085] It is therefore possible to provide a method of retrofitting a smoke extractor system or apparatus to a building, especially one which may be a high-rise building. The method may comprise the steps of providing a building, having a lift shaft and a plurality of stories, and installing an extractor fan, preferably to the top of the lift shaft, along with a plurality of vents between the lift shaft and each storey.

[0086] The words 'comprises/comprising' and the words 'having/including' when used herein with reference to the present invention are used to specify the presence of stated features, integers, steps or components, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0087] It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

[0088] The embodiments described above are provided by way of examples only, and various other modifications will be apparent to persons skilled in the field without departing from the scope of the invention as defined herein.

Claims

1. A method of retrofitting a smoke extractor system (12) to a building (14) having a plurality of storeys (16) which are interconnected by a lift shaft (54) and by a stairwell (70), the method comprising the steps of:

installing a mechanical ventilation device (18) on the lift shaft (54), the mechanical ventilation device (18) having an inlet (20) at or adjacent to the lift shaft (54) and an outlet (22) external to the building (14);

providing a smoke access path (24) on each storey (16) which couples each storey (16) to the lift shaft (54), and providing a smoke detector (38) on each of the plurality of storeys (16);

installing a controller (36) for activating the mechanical ventilation device (18) and opening and/or closing at least one of the smoke access paths (24);

providing a first air access path (28) between the stairwell (70) and the exterior of the building (14) comprising an automatically opening vent, openable by the controller (36); and

providing a second air access path between the stairwell (70) and the lift shaft (54);

- the mechanical ventilation device (18), lift shaft (54) and smoke access path (24) defining a smoke extraction system (10) such that in the event of smoke being detected by a said smoke detector (38) on at least one of the plurality of storeys (16), there is a smoke escape pathway from the or each storey (16) through the associated smoke access path (24), via the lift shaft (54) and the mechanical ventilation device (18) to an exterior of the building (14), the mechanical ventilation device (18) providing an airflow through the smoke extraction system (10); and wherein there is an air access pathway from the exterior of the building (14) through the first air access path (28), via the stairwell (70), the second air access path, the lift shaft (54) and the mechanical ventilation device (18) to the exterior of the building (14), the mechanical ventilation device (18) providing an airflow through the air access pathway.
2. A method as claimed in claim 1, wherein each smoke access path (24) is open or openable.
 3. A method as claimed in claim 2, wherein the smoke access path (24) comprises a damper valve.
 4. A method as claimed in any one of the preceding claims, wherein each smoke access path (24) is only open in the event of smoke being present on the associated storey (16).
 5. A method as claimed in claim 1 or claim 2, wherein the smoke access path (24) is a lift-shaft door (66).
 6. A method as claimed in any one of the preceding claims, further comprising the step of an associated lift car of the lift shaft (54) being moved at or adjacent to a ground storey of the building (14) in the event of smoke being detected.
 7. A method as claimed in any one of the preceding claims, further comprising the step of providing sealant between the lift shaft and the plurality of storeys (16).
 8. A method as claimed in claim 7, wherein the first air access path (28) is open or openable.
 9. A method as claimed in any one of the preceding claims, further comprising the step of installing a lift-shaft-modification apparatus to the lift shaft (54), in order that the lift shaft (54) can act as a pressurised smoke shaft.
 10. A method as claimed in claim 9, wherein the lift-shaft-modification apparatus comprises any or all of: mechanical lifting equipment; lift car; guide rails; wiring; lift controller; pulleys; cables; tracks; and counter-weights.
 11. A method as claimed in claim 9 or claim 10, wherein the lift-shaft-modification apparatus comprises at least one restraining device for restraining movable components within the lift shaft upon activation of the smoke extraction system.
 12. A method as claimed in anyone of the preceding claims, wherein the lift shaft further comprises a machine room having a barrier between the machine room and the remainder of the lift shaft (54) and the mechanical ventilation device (18) being installed with the inlet (20) adjacent to the machine room.
 13. A method as claimed in claim 12, wherein at least one smoke access aperture is formed through the barrier to provide a smoke pathway between the machine room and the remainder of the lift shaft (54).
 14. A retrofittable apparatus adapted for retro-installation of a smoke extractor system (10) to a building (14) having a plurality of storeys (16) and a lift shaft (54), the apparatus comprising:
 - at least one mechanical ventilation device (18) having an inlet (20) and an outlet (22) for the extraction of smoke from the lift shaft (54) to the exterior of the building (14); and
 - at least one vent for providing a smoke access path (24) between the lift shaft (54) and each of the storeys (16).
 15. A building (14) having a retrofitted smoke extraction system (10), the building (14) comprising:
 - a lift shaft (54);
 - a stairwell (70);
 - a plurality of storeys (16) which are interconnected by the lift shaft (54);
 - a mechanical ventilation device (18) on the lift shaft (54), the mechanical ventilation device (18) having an inlet (20) at or adjacent to the lift shaft (54) and an outlet (22) external to the building (14);
 - a smoke access path (24) on each storey (16) which couples each storey (16) to the lift shaft (54);
 - a smoke detector (38) on each of the plurality of storeys (16);
 - a controller (36) for activating the mechanical ventilation device (18) and opening and/or closing at least one of the smoke access paths (24);
 - a first air access path (28) between the stairwell (70) and the exterior of the building (14) comprising an automatically opening vent, openable by the controller (36); and

a second air access path between the stairwell (70) and the lift shaft (54);
the mechanical ventilation device (18), lift shaft (54) and smoke access path (24) defining a smoke extraction system (10) such that in the event of smoke being detected by a said smoke detector (38) on at least one of the plurality of storeys (16), there is a smoke escape pathway from the or each storey (16) through the associated smoke access path (24), via the lift shaft (54) and the mechanical ventilation device (18) to an exterior of the building (14), the mechanical ventilation device (18) providing an airflow through the smoke extraction system (10);
wherein there is an air access pathway from the exterior of the building (14) through the first air access path (28), via the stairwell (70), the second air access path, the lift shaft (54) and the mechanical ventilation device (18) to the exterior of the building (14), the mechanical ventilation device (18) providing an airflow through the air access pathway.

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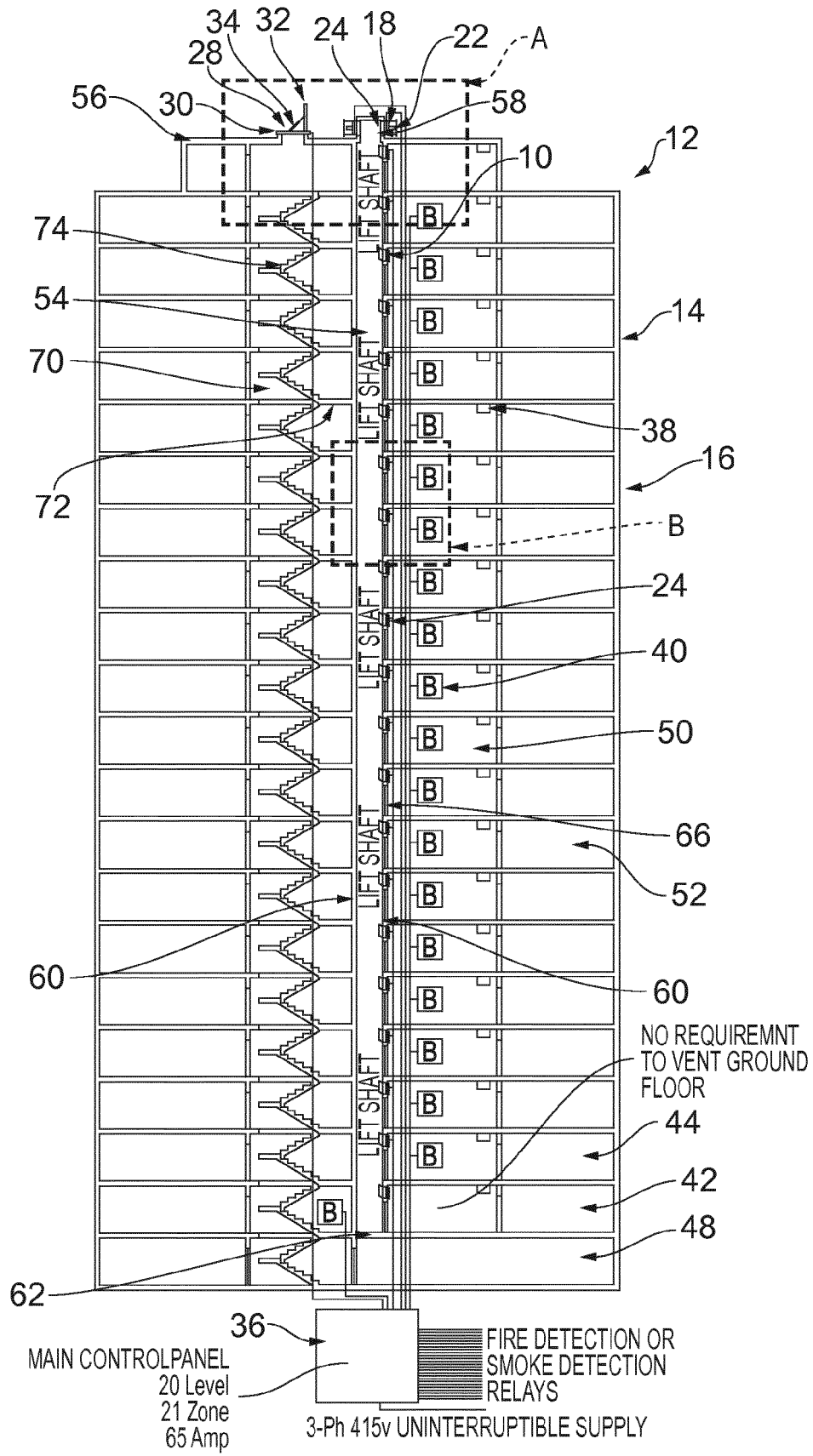
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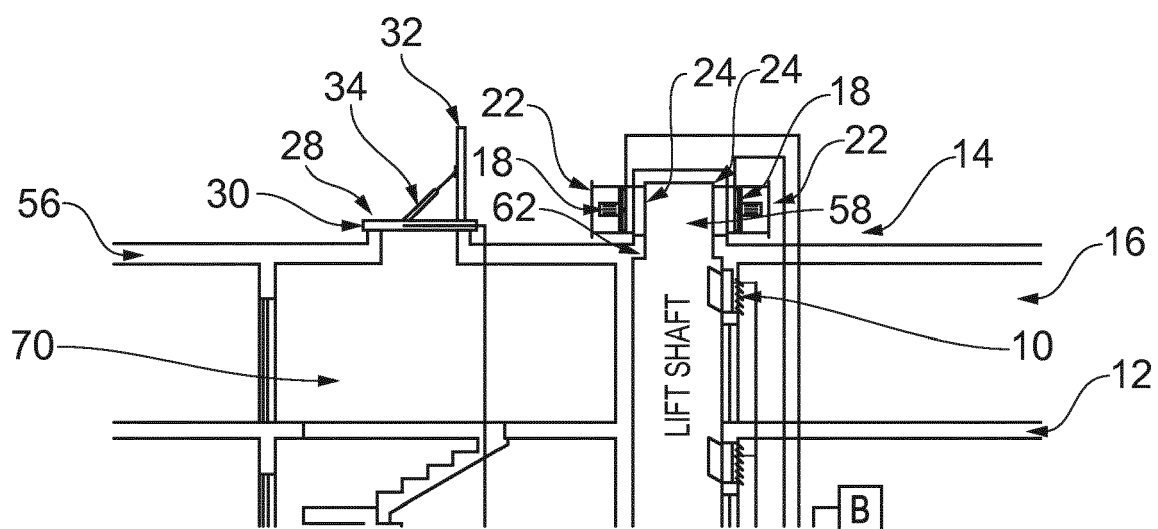


FIG. 2

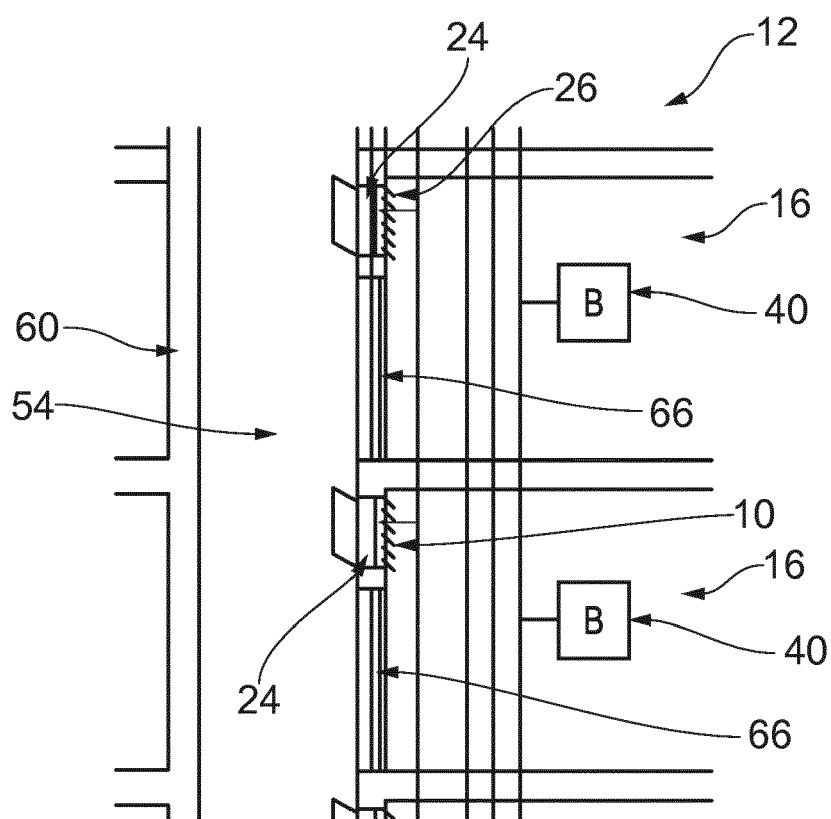


FIG. 3

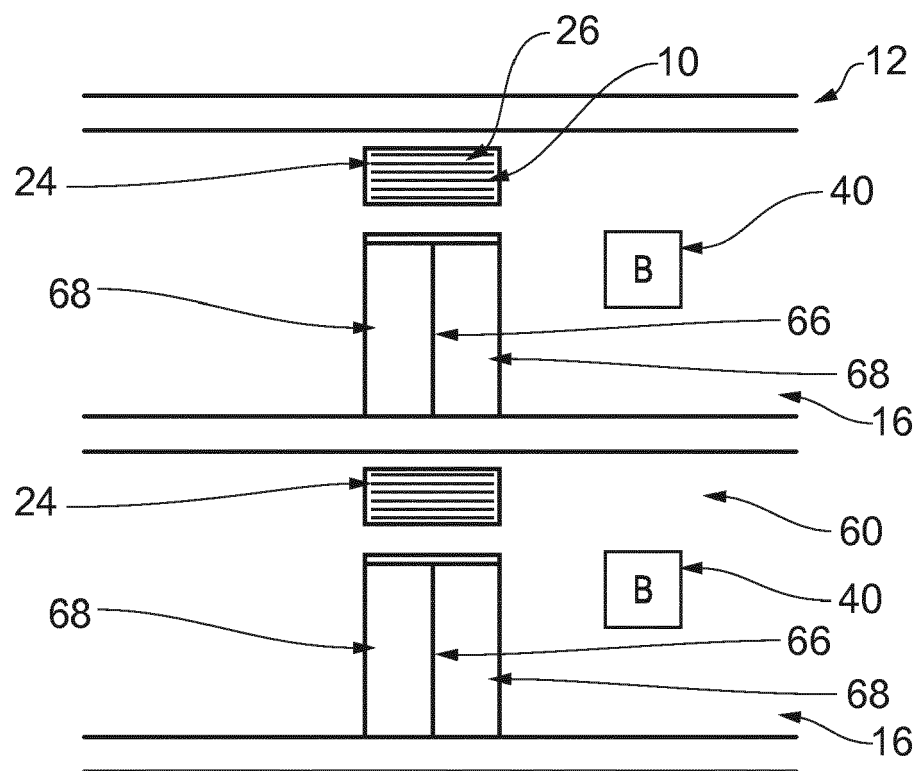


FIG. 4