

Lift installation in a building with at least one transfer storey

The invention relates to a lift installation in a building with at least one transfer storey. This invention is defined in the introductory part of the independent patent claim.

Modern lift concepts for buildings with thirty and more storeys have transfer storeys which are served by a lift installation. Such a lift installation comprises a group of at least two lifts. A first lift directly serves the transfer storeys from an entrance lobby, i.e. passengers are coarsely distributed relatively quickly from the entrance lobby by a high-speed lift to the different transfer storeys. A second lift carries out fine distribution of the passengers from the transfer storeys to the destination storeys thereof.

A lift usually comprises a lift cage, which is vertically movable in a shaft and receives passengers in order to transport these to a desired storey of a building. In order to be able to look after this task the lift usually has at least the following lift components: a drive with a motor and a drive pulley, deflecting rollers, tension means, a counterweight as well as a respective pair of guide rails for guidance of a lift cage and a counterweight.

In that case the motor produces the power required for transport of the passengers present in the lift cage. An electric motor usually looks after this function. This directly or indirectly drives a drive pulley, which is in friction contact with a tension means. The tension means can be a belt or a cable. It serves for suspension as well as conveying the lift cage and the counterweight, which both are so suspended that the gravitational forces thereof act in opposite direction along the tension means. The resultant gravitational force which has to be overcome by the drive, correspondingly substantially reduces. In addition, due to the greater contact force of the tension means with the drive pulley a greater drive moment can be transmitted by the drive pulley to the tension means. The tension means is guided by deflecting rollers.

The optimum utilisation of the shaft volume has ever increasing significance in lift construction. Particularly in high-rise buildings with a high degree of utilisation of the building a management of the passenger traffic as efficiently as possible for a given shaft volume is desired. This objective can be achieved firstly by an optimum space-saving arrangement of the lift components, which creates space for larger lift cages, and secondly by lift concepts which enable vertical movement of several independent lift cages in one

shaft.

EP 1 526 103 shows a lift installation with at least two lifts in a building, which is divided up into zones. A zone in that case comprises a defined number of storeys which are served by a lift. A zone is allocated to each lift. A transfer storey is provided in order to go from one zone to another zone. At least one of the lifts has two lift cages which are movable independently of one another vertically one above the other at two cage guide rails. The arrangement of two fetch or carry cages is to assist with preventing unnecessary waiting times at the transfer storeys.

A lift with at least two lift cages disposed one above the other in the same shaft is known from EP 1 489 033. Each lift cage has an own drive and an own counterweight. The drives are arranged near first and second shaft walls and the counterweights are also respectively suspended below the associated drive at drive or holding cables near first or second shaft walls. The axes of the drive pulleys of the drives are disposed perpendicularly to first and second shaft walls. The two independently movable lift cages ensure a high conveying performance. The positioning of the drives in the shaft near first or second walls renders a separate engine room superfluous and enables a space-saving, compact arrangement of the drive elements in the shaft head.

The object of the present invention is to further increase the conveying performance of a lift installation for a given shaft cross-section in a building with zonal division and at least one transfer storey.

The above-mentioned object is fulfilled by the invention in accordance with the definition of the independent patent claim.

The lift installation according to the invention lies in a building with at least two lifts, wherein the building is divided into building zones and each lift has at least one lift cage. Each lift cage is movable independently by way of an own drive in an associated cage zone. In addition, each cage zone has at least one transfer storey.

A first lift has at least three lift cages which are arranged vertically one above the other in a shaft and which comprise a middle and two adjacent lift cages, wherein the middle lift cage is independently movable in a middle cage zone and the two adjacent lift cages are

independently movable in two adjacent cage zones. The middle cage zone and an adjacent cage zone in that case serve at least one common storey. In addition, at least one of these cage zones is allocated to two building zones.

Thanks to the at least three lift cages, which are movable independently one above the other, of a lift the lift installation has a significantly higher conveying performance. Waiting times at transfer storeys are thus further reduced and the creation of waiting loops largely avoided. In addition, the lift installation has a greater flexibility in the allocation of journeys, because the change from one building zone to the next is possible in a classic lift model only by way of the transfer storeys. Here, regions of adjacent building zones can be reached without transfer by way of a transfer storey. A further advantage of the lift installation with such overlapping cage zones is that passengers can transfer from a middle cage zone to an adjacent cage zone at any desired storey lying in the overlap region of the cage zones. This makes possible a more flexible guidance of the passengers. In addition, storeys in the overlap region of the cage zones are served by two lift cages and thus the conveying performance of the lift installation is increased.

Advantageously this at least one lift cage of a second lift is a multi-cage with at least two cages arranged vertically one above the other. These two cages are associated with the same cage zone, since they are physically connected and can thus be moved only in common.

The advantage of the lift installation with a double-cage resides in the doubling of the available cage volume of a lift cage. Thus, up to twice as many passengers can be conveyed by one journey.

Advantageously the multi-cage serves at least two transfer storeys disposed one above the other.

The advantage of the lift installation is that in the case of doubling of the transfer storeys the waiting times on the respective transfer storeys can be further reduced. The transfer storeys have a transfer or waiting space for the transfer. In the case of a doubled number of such transfer spaces the transfer takes place substantially free of conflict and if, notwithstanding the increased conveying performance waiting times should nevertheless occur, the passengers have available twice the volume of waiting space. Staying in the

transfer storeys or transfer or waiting spaces is thus more pleasant in every instance.

Advantageously the at least three cage zones can be allocated to at least two adjacent building zones. Equally advantageously the middle cage zone is allocated to a building zone and the two adjacent cage zones are each allocated to the same building zone and an adjacent upper or lower building zone.

The advantage of the lift installation resides in the flexible passenger guidance. In the said form of embodiment it is possible to change from one storey of a building zone to a storey of an adjacent building zone without the possible transfer by way of a transfer storey having to be taken into account.

Advantageously the at least three drives associated with the lift cages can be moved past by the lift cages.

The lift installation has the advantage that the drives can be arranged in space-saving and flexible manner in the shaft without coming into conflict with the lift cages.

Advantageously the at least three drives (A1) associated with the lift cages are positioned at a first shaft wall or a second, opposite shaft wall.

The advantage of the lift installation resides in the position of the drives between lift cages and first and second shaft walls. Space in the shaft head or shaft pit, where the drives are usually arranged, can thereby be saved.

Advantageously the drive of the middle lift cage is positioned at the first shaft wall and the two drives of the adjacent lift cages are positioned at the opposite, second shaft wall.

The advantage of the lift installation resides in the flexible and simple positioning of however many drives and the associated lift cages in the same shaft. In a conventional arrangement of the drives in the shaft head, thereagainst, the number of drives which can be installed is limited by the space available in the shaft head. Equally, a guidance of the tension elements free of conflict in such a conventional arrangement of the drives in the shaft head is subject to close limits.

The invention is clarified and further described in detail in the following by examples of embodiment and drawings, in which:

- Fig. 1 shows a schematic side view of an arrangement of a lift of a lift installation with three lift cages, three drives, three drive pulleys, three tension means and several deflecting rollers;
- Fig. 2 shows a schematic plan view of an arrangement of the lift of a lift installation according to Fig. 1;
- Fig. 3 shows a schematic plan view of an optional arrangement of a lift of a lift installation according to Fig. 1;
- Fig. 4 shows a side view of an arrangement of the drives on cross members;
- Fig. 5 shows a schematic side view of a lift installation according to the invention in a building with two building zones,
- Fig. 6 shows a schematic side view of a lift installation according to the invention in a building with four building zones;
- Fig. 7 shows a schematic side view of a lift installation with alternative arrangement in a building with three building zones; and
- Fig. 8 shows a schematic side view of a lift installation with alternative arrangement in a building with seven building zones.

The shaft is a space which is defined by six boundary planes and in which one or more lift cages are moved along a travel path. Usually four shaft walls, a ceiling and a floor form these six boundary planes. This definition of a shaft can be extended in the manner that several travel paths, along each of which one or more lift cages are movable, can also be arranged in a shaft horizontally adjacent to one another.

Figure 1 shows a lift with at least three lift cages 7a, 7b, 7c which each have an own drive A1, A2, A3 and are movable independently of one another in vertical direction. In that

case a middle lift cage 7a is arranged between two adjacent lift cages 7b, 7c, which are disposed respectively below and above the middle lift cage 7a.

The associated drives A1, A2, A3 are positioned laterally at first and second shaft walls. The first and second shaft walls are those mutually opposite shaft walls not having shaft doors. The drive A1 of the middle lift cage 7a is positioned at the first shaft wall and the two drives A2, A3 of the adjacent lift cages 7b, 7c are positioned at the opposite second shaft wall. In that case the drives A1, A2, A3 are positioned in alternation on opposite shaft walls. Additional drives (not shown) of further lift cages are alternately arranged at first and second shaft walls in correspondence with the alternating ordering of the drives.

The drives A1, A2, A3 are positioned in Fig. 1 at three different shaft heights, wherein the drives A2, A3 of adjacent lift cages 7b, 7c are positioned above or below the drive A1 of the middle lift cage 7a. As a rule the distance in vertical direction between a middle drive A1 and an adjacent drive A2, A3 is at least one cage height.

It is, however, also possible to position two drives at the same shaft height. For example, the drive A1 of the middle lift cage 7a can be arranged on a first shaft wall and the drive A3 of the adjacent, upper lift cage 7c on the opposite, second shaft wall at the same shaft height. The advantage of this arrangement resides in the simple maintenance of the two drives A1, A3. These can, in particular, be maintained from a common platform.

A drive A1, A2, A3 has a respective motor M1, M2, M3 and a respective drive pulley 1a, 1b, 1c. The motor M1, M2, M3 is disposed in operative contact with the drive pulley 1a, 1b, 1c and drives the tension means Z1, Z2, Z3 by means of this drive pulley 1a, 1b, 1c. The drive pulley 1a, 1b, 1c is so designed that it is suitable for receiving one or more tension means Z1, Z2, Z3. The tension means Z1, Z2, Z3 are preferably belts, such as wedge-ribbed belts with ribs at one side which engage in one or more depressions at the drive pulley side. Belt variants such as smooth belts and belts toothed on one side or both sides with corresponding drive pulleys 1a, 1b, 1c are equally usable. In addition, different kinds of cables such as single cables, double cables or multiple cables are also usable. The tension means Z1, Z2, Z3 comprise strands of steel wire or aramide or Vectran.

The at least three lift cages 7a, 7b, 7c and three counterweights 12a, 12b, 12c are suspended at the tension means Z1, Z2, Z3 in block-and-tackle manner. In that case the

lift cages 7a, 7b, 7c have at least one first and at least one second deflecting roller 2a, 2b, 2c, 3a, 3b, 3c which are fastened in the lower region of the lift cages 7a, 7b, 7c. These deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c have, at the outer circumference, one or more grooves which are such that they can receive one or more tension means Z1, Z2, Z3. The deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c are thus suitable for the guidance of tension means Z1, Z2, Z3 and are brought into contact with the latter. A lift cage 7a, 7b, 7c is thus preferably suspended as a lower block-and-tackle.

In an optional form of embodiment the deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c are disposed in the upper region of the lift cage 7a, 7b, 7c. In correspondence with the above description, the lift cage 7a, 7b, 7c is then suspended as an upper block-and-tackle.

Disposed in the upper region of the counterweights 12a, 12b, 12c is a third deflecting roller 4a, 4b, 4c, which is similarly suitable, analogously to the deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c, to receive one or more tension means Z1, Z2, Z3. Correspondingly, the counterweight 12a, 12b, 12c is preferably suspended at the third deflecting roller 4a, 4b, 4c as an upper block-and-tackle below the associated drive A1, A2, A3.

The tension means Z1, Z2, Z3 is led from a first fixing point 5a, 5b, 5c to a second fixing point 6a, 6b, 6c via first, second and third deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c, 4a, 4b, 4c and the drive pulley 1a, 1b, 1c from a first shaft wall to the second shaft wall. The first fixing point 5a, 5b, 5c is in that case disposed opposite the associated drive A1, A2, A3 at approximately the same shaft height in the vicinity of a first or second shaft wall. The second fixing point 6a, 6b, 6c is disposed in the vicinity of the associated drive A1, A2, A3 on an opposite second or first shaft wall.

The tension means Z1, Z2, Z3 runs from the first fixing point 5a, 5b, 5c along a first or second shaft wall downwardly to the second deflecting roller 3a, 3b, 3c, loops around this from the outside to the inside at an angle of approximately 90° and leads to the first deflecting roller 2a, 2b, 2c. The tension means Z1, Z2, Z3 loops around this first deflecting roller 2a, 2b, 2c from the inside to the outside again through approximately 90° and is thereafter led along the lift cage 7a, 7b, 7c upwardly to the drive pulley 1a, 1b, 1c and loops around this from the inside to the outside through approximately 150°. Depending on the setting of the optional setting pulley 13a, 13b, 13c the looping angle can be set in a range of 90 to 180°. The tension means Z1, Z2, Z3 is thereafter led along a second or first

shaft wall downwardly to the third deflecting pulley 4a, 4b, 4c, loops around this from the outside to the inside through approximately 180° and is again led along a second or first shaft wall upwardly to the second fixing point 6a, 6b, 6c.

As mentioned above, a setting pulley 13a, 13b, 13c is an optional component of the drive A1, A2, A3. With this setting pulley 13a, 13b, 13c the looping angle of the tension means Z1, Z2, Z3 at the drive pulley 1a, 1b, 1c can be set, or increased or reduced, in order to transmit the desired traction forces from the drive pulley 1a, 1b, 1c to the tension means A1, A2, A3. Depending on the respective spacing of the setting pulley 13a, 13b, 13c from the drive pulley 1a, 1b, 1c the spacing of the tension means Z1, Z2, Z3 from the drive A1, A2, A3, from the counterweight 12a, 12b, 12c or from the lift cage 7a, 7b, 7c can additionally be set. A conflict-free guidance of the tension means Z1, Z2, Z3 in the shaft between the drive pulley 1a, 1b, 1c and the first deflecting roller 2a, 2b, 2c is thus guaranteed.

A lift cage 7a, 7b, 7c as well as the respectively associated drives A1, A2, A3, drive pulleys 1a, 1b, 1c, deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c, 4a, 4b, 4c, optional setting pulleys 13a, 13b, 13c, counterweights 12a, 12b, 12c, tension means Z1, Z2, Z3 and fixing points 5a, 5b, 5c, 6a, 6b, 6c form a lift unit. Consequently, Fig. 1 shows a lift which has three lift units, which in turn forms a triple group 14.

Proceeding from the middle lift unit with the lift cage 7a, the adjacent lower lift unit with the lift cage 7b and an adjacent upper lift unit with lift cage 7c are respectively arranged in mirror image with respect to the middle one. The drives A1, A2, A3 of the lift units thus lie on mutually opposite first or second shaft walls and the associated drive pulleys 1a, 1b, 1c, deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c, 4a, 4b, 4c, setting pulleys 13a, 13b, 13c, counterweights 12a, 12b, 12c, tension means Z1, Z2, Z3 and fixing points 5a, 5b, 5c, 6a, 6b, 6c of adjacent lift cages 7a, 7b, 7c are also arranged in mirror image. This rule of mirror-image arrangement of middle and adjacent lift units applies to any desired number of lift units installed in a shaft.

A further characteristic of the arrangement of the lift units is that the associated drives A1, A2, A3 and first fixing points 5a, 5b, 5c are positioned at approximately the same height at opposite first and second shaft walls. The shaft height predetermined by the fixing points 5a, 5b, 5c and drives A1, A2, A3 is also at the same time the highest point which an

associated lift cage 7a, 7b, 7c can reach, since the tension means in the illustrated form of embodiment cannot raise a suspension point of a lift cage 7a, 7b, 7c above the height of the drive pulley 1a, 1b, 1c. The positioning of the drives A1, A2, A3 and first fixing points 5a, 5b, 5c of the middle and adjacent lift cages 7a, 7b, 7c is usually carried out at different shaft heights. The lift cages 7a, 7b, 7c can thus reach only different maximum shaft heights. Correspondingly, the middle and the adjacent lift cages 7a, 7b, 7c are allocated to different cage zones in which the lift cages 7a, 7b, 7c are movable.

The cage zones K1, K2, K3 allocated to the lift cages 7a, 7b, 7c are evident in Fig. 1. It is apparent therefrom that the shaft height of a drive A1, A2, A3 in the afore-described configuration predetermines the maximum shaft height of such a cage zone K1, K2, K3. The minimum shaft height of a cage zone K1, K2, K3, thereagainst, is defined by the drive A1, A2, A3 of the next-but-one lift unit disposed thereunder. In the illustrated example of embodiment the counterweight 12c of the adjacent upper lift cage 7c and the drive A2 of the next-but-one adjacent lower lift cage 7b disposed thereunder is disposed, due to the mirror-image construction of middle and adjacent lift units, on the same first or second shaft wall. The deepest shaft height reachable by the counterweight 12c is thus limited by the drive A2 disposed thereunder on the same shaft wall. The travel range of the counterweight 12c between drive A2 and the drive A3 thus defines, for simultaneous 2:1 suspension of the associated lift cage 7c and counterweight 12c, the cage zone K3 of the lift cage 7c.

If use is made of this teaching for the triple group 14, partly overlapping cage zones K1, K2, K3 result, wherein only middle and adjacent cage zones K1, K2, K3 overlap. In a high-rise building with several triple groups 14 arranged one above the other all storeys disposed in a middle cage zone K1 are thus served by two lift cages.

According to Fig. 2 the lift cages 7a, 7b, 7c are guided by two cage guide rails 10.1, 10.2. The two cage guide rails 10.1, 10.2 form a connecting plane V which extends in each instance approximately through the centre of gravity S of the two lift cages 7a, 7b, 7c. In the illustrated form of embodiment the lift cages 7a, 7b, 7c are suspended eccentrically. Here only the arrangement of two lift units arranged directly one above the other is shown. However, it is clear to the expert that the arrangement for further pairs of lift units arranged directly one above the other takes place analogously thereto.

The tension means Z1, Z2, Z3 and the associated guide means, such as deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c, 4a, 4b, 4c and drive pulleys 1a, 1b, 1c, in this suspension arrangement lie on one side of the connecting plane V, wherein the deflecting rollers 4a, 4b, 4c are, for the sake of clarity, not illustrated in Fig. 2, i.e. all afore-mentioned components associated with a lift cage 7a, 7b, 7c lie either between third shaft walls and the connecting plane V or between fourth shaft walls and the connecting plane V. Third or fourth shaft walls denote shaft walls which have at least one shaft door 9 and opposite shaft walls. The spacing y of the tension means Z1, Z2, Z3 and the connecting plane V is advantageously approximately the same. The tension means Z1, Z2, Z3 of a lift cage 7a, 7b, 7c lie alternately on one or the other side of the connecting plane V. Thus, the moments produced by the eccentric suspension of the lift cages 7a, 7b, 7c have opposite effect. In the case of the same rated load of the lift cages 7a, 7b, 7c and in the case of an even number of the lift cages 7a, 7b, 7c the moments acting on the guide rails 10.1, 10.2 significantly rise.

The counterweights 12a, 12b, 12c are guided by two counterweight guide rails 11a.1, 11a.2, 11b.1, 11b.2. The counterweights 12a, 12b, 12c are positioned at opposite shaft walls between the cage guide rails 10.1, 10.2 and first or second shaft walls. Advantageously, the counterweights 12a, 12b, 12c are suspended at their centre of gravity at the tension means Z1, Z2, Z3. Since the lift cages 7a, 7b, 7c are eccentrically suspended, the counterweights 12a, 12b, 12c are laterally offset in the vicinity of third and fourth shaft walls.

The axes of rotation of the drive pulleys 1a, 1b, 1c and of the deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c, 4a, 4b, 4c lie parallel to the first or second shaft walls. In the illustrated embodiment the afore-mentioned components are of the form that they can accept four parallelly extending tension means Z1, Z2, Z3, guide these or, in the case of the drive pulley 1a, 1b, 1c, also drive these. In order to be able to receive the tension means Z1, Z2, Z3 the deflecting rollers 2a, 2b, 2c, 3a, 3b, 3c, 4a, 4b, 4c and drive pulleys 1a, 1b, 1c have four specially constructed contact surfaces, which in the case of cables are designed, for example, as grooves or in the case of belts, for example, also as dished surfaces or toothings or, in the case of a contact surface of flat construction, are provided with guide shoulders. These four contact surfaces can be formed either on a common roller-shaped base body or respectively on four individual rollers with a common axis of rotation.

With knowledge of this form of embodiment numerous possibilities of variation according to the respective objective are available to the expert. Thus, this can arrange one to four or more individual rollers with or without a spacing relative to one another on one axis of rotation. In that case each roller can accept, depending on the respective design, one to four or, in the case of need, even more tension means Z1, Z2, Z3.

In normal operation of the lift the lift cages 7a, 7b, 7c are placed at a storey stop flushly with the storey and the cage doors 8 are opened together with the shaft doors 9 so as to enable transfer of passengers from the storey to the lift cages 7a, 7b, 7c and conversely.

Fig. 3 shows an alternative suspension arrangement with centrally suspended lift cages 7a, 7b, 7c. Here only the arrangement of two lift units arranged directly one above the other is shown. However, it will be clear to the expert that the arrangement for further pairs of lift units arranged directly one above the other takes place analogously thereto.

In that case the tension means Z1, Z2, Z3 are led from the deflecting rollers and drive pulleys 1a, 1b, 1c on both sides of the connecting plane V. Advantageously, the suspension is then arranged symmetrically with respect to the connecting plane V. Since in this case the suspension centre of gravity substantially coincides with the centre of gravity S of the lift cages 7a, 7b, 7c no additional moments act on the cage guide rails 10.1, 10.2.

In this central suspension of the lift cages 7a, 7b, 7c the associated deflecting rollers 2a.1, 2a.2, 2b.1, 2b.2, 3a.1, 3a.2, 3b.1, 3b.2 and drive pulleys 1a.1, 1a.2, 1b.1, 1b.2 consist of at least two rollers arranged on the left and right of the connecting plane V. The deflecting rollers 4a, 4b, 4c of the counterweights 12a, 12b, 12c similarly consist of two rollers arranged on the left and the right of the connecting plane V, but for the sake of clarity not illustrated in Fig. 3. In the present example the deflecting rollers 2a.1, 2a.2, 3a.1, 3a.2 and the drive pulleys 1a.1, 1a.2, which are associated with the middle lift cage 7a, lie at a first spacing x from the connecting plane V and the deflecting rollers 2b.1, 2b.2, 3b.1, 3b.2 and the drive pulley 1b, which are associated with the adjacent lower lift cage 7b, at a second spacing X from the connecting plane V, wherein the first spacing x is smaller than the second spacing X. A conflict-free guidance of the tension means Z1, Z2, Z3 in the case of central suspension of the lift cages 7a, 7b, 7c is thereby guaranteed.

Here, too, the counterweights 12a, 12b, 12c are advantageously suspended at their centre of gravity S at the tension means Z1, Z2, Z3 between the cage guide rails 10.1, 10.2 and first or second shaft walls. Since the lift cages 7a, 7b, 7c are now centrally suspended, the counterweights 12a, 12b, 12c also lie in a central region of the first and second shaft walls. Thanks to this central position of the counterweights 12a, 12b, 12c the free space between the lateral ends of the counterweights 12a, 12b, 12c and third and fourth shaft walls increases. Design freedom for the counterweights 12a, 12b, 12c is thereby gained. Thus, for example, a narrower and wider counterweight 12a, 12b, 12c can be used in order to better utilise the space. For a given shaft cross-section, the lift cage 7a, 7b, 7c gains width or, for a given cage size, the shaft cross-section can be reduced.

The centric and eccentric suspension variants, which are shown in Figs. 2 and 3, can be combined as desired with the following examples of Figs. 5 and 6.

As shown in Fig. 4, the drive A1 has a motor M1, preferably an electric motor, a drive pulley 1a and optionally a setting pulley 13a by which the looping angle of the tension means Z1 about the drive pulley 1a and the horizontal spacing of the tension means Z1 from the drive A1 to the lift cage 7a or counterweight 12a can be set.

The motor M1 lies vertically above the drive pulley 1a. Thanks to this arrangement the drive can be positioned in the clear projection of the counterweights 12a between the lift cages 7a and first and second shaft walls. The drives A1 can thereby be moved past by the lift cages 7a and can thus be mounted in an otherwise unneeded space of the shaft. By comparison with conventional lifts without an engine room there is thereby obtained space in the shaft head and/or in the shaft pit.

According to Fig. 4 the drive A1 is fixed on a cross member 19, which is fastened to a cage guide rail 10.1 and/or to the counterweight guide rails 11a.1, 11a.2. There can be further seen in Fig. 4 the third deflecting roller 4a, at which the counterweight 12a is suspended, and in the background the lift cage 7a. The example shown here is in mirror image with respect to the connecting plane V by comparison with the arrangement of Fig. 2.

The drives A1 can also be optionally fixed directly on the shaft walls and in that case the cross members 19 are saved.

Fig. 5 shows a lift installation for a building with zonal division. A building zone G1, G2 is composed of several storeys of the building arranged vertically one above the other. In that case at least one of these storeys of a building zone G1, G2 is a so-termed transfer storey U1, U2. It is usual to go from one building zone G1 to another building zone G2 by means of a feeder lift which stops only at the transfer storeys. Here this feeder lift is designed as a high-speed lift. The number of remaining storeys which are allocated to a building zone G1, G2 is defined by those storeys which are served by a take-away lift 14.1, 14.2. This take-away lift 14.1, 14.2 undertakes fine distribution of the passengers from the transfer storeys U1, U2 to the destination storeys thereof. In the illustrated example a certain number of storeys which are served by two take-away lifts 14.1, 14.2 of adjacent building zones G1, G2 is provided in the edge region of two adjacent building zones G1, G2. The boundary of the building zones G1, G2 is fixed by the centre of this edge zone.

The building is here divided into two building zones G1, G2. Allocated to each of these building zones G1, G2 is a triple group 14.1, 14.2. The lift installation further comprises two lifts which are arranged in two shafts 15.1, 15.2. Disposed in the first shaft 15.1 are two triple groups 14.1, 14.2, which are arranged vertically one above the other, with six lift units and the associated six cage zones K1.1, K1.2, K1.3, K2.1, K2.2, K2.3.

A high-performance lift which exclusively serves transfer storeys U1.2, U1.1, U2.1, U2.2 is moved in the second lift shaft 15.2. This high-performance lift is, in the illustrated example, a double-decker lift with two fixedly connected cages which are arranged vertically one above the other and movable in common in the shaft 15. These double-decker cages serve two transfer storeys U1.2, U1.1, U2.1, U2.2 arranged directly one above the other.

A primary task of the two triple groups 14.1, 14.2 is the transport of passengers from the transfer storeys U1.1, U1.2, U2.1, U2.2 to the destination storeys of the corresponding building zone G1, G2 and back again. The triple groups 14.1, 14.2, however, also ensure transport within the respective building zone G1, G2 as well as to a region of the adjoining building zone G1, G2.

Accordingly, the first cage K3.1 of the first triple group 14.1 and the lowermost cage zone K2.2 of the second triple group 14.2, which both lie at the boundary of the cage zones G1,

G2, each have a region of storeys which respectively lies in the adjoining building zone G1, G2. It is now possible within one of the said cage zones K3.1, K2.2 to reach storeys of the respective adjoining building zone G1, G2. This offers, apart from the classic change of building zones G1, G2 via a transfer storey U1.1, U1.2, U2.1, U2.2, additional possibilities in order to pass from one building zone G1, G2 to another, adjoining building zone G1, G2. Thanks to this arrangement, which extends over building zones, of the triple groups 14.1, 14.2 the lift installation is distinguished by a flexible allocation of journeys.

Each cage zone K1.1, K1.2, K1.3, K2.1, K2.2, K2.3 in each building zone G1, G2 has at least one transfer storey U1.2, U1.1, U2.1, U2.2. The following arrangement, by way of example, results in the upper building zone G2: the transfer storeys U2.1, U2.2 of the double-decker lift lie in a central region of the building zone G2, the lower transfer storey U2.2 is served by the lower cage of the double-decker cage and the middle and lower adjacent lift cage of the triple group 14.1 and the upper transfer storey U2.1 is served correspondingly by the upper cage of the double-decker cage and the middle and upper adjacent lift cage of the triple group 14.2. Thus, passengers whose destination storey lies in the middle cage zone K1.2 always have available two lift cages of the triple group 14.2 for onward travel.

The adjacent cage zones K2.2, K3.2 preferably each contain half the storeys of a building zone G2. Towards the top the upper cage zone K3.2 is bounded by the end of the cage zone G2. The lower cage zone K2.2, thereagainst, extends beyond the lower end of the building zone G2 into the building zone G1 and is bounded downwardly by the middle cage zone K1.1 of the building zone G1 or by the associated drive.

The middle cage zone K1.2 has at least two storeys, which correspond with the transfer storeys. Preferably, however, the middle cage zone K1.2 extends over as many storeys as possible of the building zone G2. Towards the top the middle cage zone K1.2 is bounded by the lift cage of the upper adjacent cage zone K3.2, because the lift cage of the middle cage zone K1.2 cannot, due to the vertical stacking of the lift cages of a triple group 14.2, move past the upper adjacent lift cage. The lower boundary of the middle cage zone K1.2 results from the position of the drive which is associated with the next-but-one lift cage disposed thereunder. This drive is allocated to the upper cage zone K3.1 of the lower triple group 14.1. In the case of minimum size of the middle cage zone K1.2 of two storeys the middle lift cage of the triple group 14.2 takes over for the building zone G2 the

function of an escalator 16, in that it transports passengers from the upper transfer storey U2.1 to the lower transfer storey U2.2 and conversely.

The lower triple group 14.1 and the associated cage zones K1.1, K2.1, K3.1 are arranged in point symmetrical manner with respect to the upper triple group 14.2, wherein the point of symmetry lies in the centre of the shaft 15.1 at a shaft height corresponding with the boundary line between the building zones G1, G2. Correspondingly, the transfer storeys U1.1, U1.2 also lie in a middle region of the building zone G1. The middle cage zone K1.1 serves both transfer storeys U1.1, U1.2 as well as further storeys of the building zone G1. The said cage zone K1.1 is bounded at the top by its associated drive and at the bottom by the lower adjacent lift cage. The upper adjacent cage zone K3.1 is arranged, analogously to the lower cage zone K2.2 of the upper building zone G2, to extend over building zones. The cage zone K3.1 extends from its associated drive downwardly to the drive of the next-but-one lift cage which is disposed in thereunder and which serves the storeys in the cage zone K2.1. This lower adjacent cage zone K2.1 adjoins at the top, as stated, the upper adjacent cage zone K3.1 and at the bottom the lower end of the building zone K1.

The two transfer storeys U1.1, U1.2 of the lower building zone G1 are connected by an escalator 16. The escalators are often used in building lobbies. The building lobbies are storeys in which the passengers enter the building and also leave again and are accordingly frequented by numerous passengers. If, for example, the lower transfer storey U1.2 is now a building lobby, the inflowing passengers now pass, in the case of need, rapidly to the upper transfer storey U1.1 thanks to the high conveying performance of the roller escalator 16 or pass, when leaving the building, rapidly from this back to the building lobby. Depending on the respective kind and position of the building the building lobby can in principle lie on any storey of the building. The building lobby is in that case usually served by at least one high-speed lift of the second shaft 15.2.

The example shown in Fig. 5 is continuously served by two lift cages of the triple groups arranged vertically one above the other in the first shaft 15.1. An exception is formed solely by the uppermost and the lowermost storey of the building. These two storeys are served only by the lift cage of the uppermost and lowermost cage zone K2.1, K3.2. This is a substantial advantage by comparison with a classic lift installation with triple groups 14.1, 14.2 allocated exclusively to a building zone G1, G2, because in such classic lift

installations there are in each instance two boundary storeys, which are served by only one lift cage, per building zone G1, G2. Thus, the described lift installation has a particularly high conveying performance.

Fig. 6 shows a building with a lift installation which is configured according to the example of Fig. 4. The building here has, however, two additional building zones G3, G4 with two associated triple groups 14.3, 14.4. These two triple groups 14.3, 14.4 have six lift cabins, which are movable in six associated cage zones K1.3, K2.3, K3.3, K1.4, K2.4, K3.4. In addition, two respective transfer storeys U3.1, U3.2, U4.1, U4.2 are associated with each of the two additional building zones G3, G4. According to this example, any number of triple groups 14 can be arranged in a shaft 15.1 vertically one above the other depending on the respective building height or number of storeys which form a building zone G1, G2, G3, G4.

Fig. 7 describes the lift installation in a building with three building zones G1, G2, G3 and two shafts 15.1, 15.2. Arranged in a first shaft 15.1 one above the other are five lift units with corresponding lift cages 17.1-5, which are independently movable in five cage zones K1.1, K1/2, K1.2, K2/3, K3.1. The three building zones G1, G2, G3 each have two transfer storeys U1.1, U1.2, U2.1, U2.2, U3.1, U3.2 which are each disposed in a middle region of the associated building zones G1, G2, G3.

The lowermost lift cage 17.1, the next-but-one lift cage 17.3 disposed thereabove and the uppermost lift cage 17.5 define each time three associated cage zones K1.1, K1.2, K1.3, which substantially correspond with the three associated building zones G1, G2, G3. Two further lift cages 17.2, 17.4 are disposed between these three lift cages 17.1, 17.3, 17.5. These two lift cages 17.2, 17.4 are movable in two associated cage zones K1/2, K2/3. These two cage zones K1/2, K2/3 are arranged to extend over building zones. In the lowermost building zone G1 an escalator 16 transports passengers between the two transfer storeys U1.1, U1.2.

Fig. 8 shows a lift installation with a building zone division and cage zone division as in the example of Fig. 7. The building has four additional building zones G4, G5, G6, G7 with associated transfer storeys U4.1, U4.2, U5.1, U5.2, U6.1, U6.2, U7.1, U7.2 and four cage zones K1.4, K1.5, K1.6, K1.7 with corresponding lift cages 17.7, 17.9, 17.11, 17.13, which exclusively serve storeys of associated building zones G4, G5, G6, G7. Added thereto are

four cage zones K3/4, K4/5, K5/6, K6/7 with corresponding lift cages 17.6, 17.8, 17.10, 17.12, which are arranged to extend over the building.

The invention is not restricted only to the illustrated forms of embodiment. With knowledge of the invention it is obvious to the expert to optimise different parameters for specific forms of building. Instead of a double-decker cage it is also possible for several or individual single cages or multi-cages, which have more than two cages connected together, to be moved in a second shaft 15.2. In addition, the number of storeys allocated to a building zone G is freely selectable. The building zones G also do not need to have the same number of storeys, but the number can vary from building zone to building zone. It is also not always necessary for only triple groups 14 to be assigned to a building zone G. Thus, quadruple, quintuple or sextuple groups, etc., can also be assigned to the building zones G. The cabin zones do not have to be symmetrically constructed, for example, within a triple group. Depending on the position of the drives and the transfer storeys these cage zones K are freely adaptable to the specific building conditions. Finally, the transfer storeys U can also be freely arranged with respect to number and position in a building zone G in dependence on cage zones K or number of cages of a multi-cage.

The following simple calculation shows that thanks to the invention a significant increase in conveying performance can be achieved. For a building zone G2 with, for example, twelve storeys, according to the state of the art two lift cages each serve eleven storeys, i.e. each lift cage has per storey a transport coefficient of $1/11$ weighted by the number of storeys to be served, which coefficient represents a measure for the conveying performance of the lift cage in a specific storey. This gives for the two boundary storeys, which are each served only by one lift cage, a transport coefficient each of $1/11$ and, for a central region of eight storeys where the two cage zones overlap, a transport coefficient of $2/11$.

According to the example of Fig. 6 the following calculation results for a middle building zone G3: each lift cage moved in the building zone G3 has an associated cage zone which embraces eight storeys. Since each storey of the building zone G3 is served by two lift cages, there results a continuous transport coefficient of $2/8$ or $1/4$. The conveying performance thus lies significantly above the values of a comparable lift installation according to the state of the art.

In the second arrangement, which is shown in Fig. 8, of the lift installation the transport coefficient for storeys of a middle building zone G4 is calculated according to similar considerations as before. Each lift cage moved in the building zone G4 has an associated cage zone embracing twelve storeys. In this case as well each storey of the building zone G4 is served by two lift cages. Thus, a transport coefficient of $2/12$ results for each storey of the building zone G4. In the case of serving of the middle storeys at approximately the same frequency, the boundary storeys in this example can be served significantly more frequently than in the case of a lift installation according to the state of the art.

Claims

1. Lift installation in a building with at least two lifts, wherein the building is divided into building zones (G1, G2; G3, G4) and each lift has at least one lift cage (7a, 7b, 7c), each lift cage (7a, 7b, 7c) is independently movable by way of an own drive (A1, A2, A3) in an associated cage zone (K1, K2, K3; K1.1, K2.1, K3.1, K1.2, K2.2, K3.2) and each cage zone (K1, K2, K3; K1.1, K2.1, K3.1, K1.2, K2.2, K3.2) has at least one transfer storey (U1.1, U1.2, U2.1, U2.2) and at least one further transfer storey, characterised in that a first lift has at least three lift cages (7a, 7b, 7c) which are arranged vertically one above the other in a shaft (15.1) and which comprise a middle and two adjacent lift cages, wherein the middle lift cage (7a) is independently movable in a middle cage zone (K1; K1.1, K1.2) and the two adjacent lift cages (7b, 7c) are independently movable in two adjacent cage zones (K2, K3; K2.1, K3.1, K2.2, K3.2), and that the middle cage zone (K1, K1.1, K1.2) and an adjacent cage zone (K2, K3; K2.1, K3.1, K2.2, K3.2) serve at least one common storey and that at least one of these cage zones (K1.1, K2.1, K3.1, K1.2, K2.2, K3.2) is allocated to two building zones (G1, G2).
2. Lift installation according to claim 1, characterised in that this at least one lift cage of a second lift is a multi-cage with at least two cages which are arranged vertically one above the other and which are associated with the same cage zone.
3. Lift installation according to claim 2, characterised in that the multi-cage serves at least two transfer storeys (U1.1, U1.2, U2.1, U2.2) disposed one above the other.
4. Lift installation according to any one of the preceding claims, characterised in that the at least three cage zones are associated with at least two adjacent building zones.
5. Lift installation according to claim 4, characterised in that the middle cage zone is associated with one building zone and the two adjacent cage zones are each associated with the same building zone and an adjacent upper or lower building zone.
6. Lift installation according to claim 4, characterised in that the at least three drives (A1, A2, A3) associated with the lift cages (7a, 7b, 7c) can be moved past by the lift cages (7a, 7b, 7c).

7. Lift installation according to claim 4 or 6, characterised in that the at least three drives (A1, A2, A3) associated with the lift cages (7a, 7b, 7c) are positioned at a first shaft wall or a second opposite shaft wall.
8. Lift installation according to claim 7, characterised in that the drive (A1) of the middle lift cage (7a) is positioned at the first shaft wall and the two drives (A2, A3) of the adjacent lift cages (7b, 7c) are positioned at the opposite second shaft wall.
9. Lift installation according to claim 7 or 8, characterised in that the at least three drives (a1, a2, a3) are positioned in alternation on opposite first or second shaft walls.
10. Lift installation according to any one of claims 6 to 9, characterised in that the at least three drives (A1, A2, A3) are positioned at different shaft heights.
11. Lift installation according to claim 10, characterised in that the drives (A2, A3) of the adjacent lift cages (7b, 7c) are arranged above or below the drive (A1) of the middle lift cage (7a).
12. Lift installation according to claim 10 or 11, characterised in that the distance in vertical direction between the two drives (A1) of a middle and an adjacent lift cage (A2, A3) is at least one cage height.
13. Lift installation according to any one of claims 6 to 8, characterised in that two drives (A1, A3) are positioned at the same shaft height.
14. Lift installation according to any one of the preceding claims, characterised in that the drive (A1, A2, A3) has at least one motor (M1, M2, M3) and drive pulley (1a, 1b, 1c).
15. Lift installation according to claim 14, characterised in that the motor (M1, M2, M3) is arranged vertically above the associated drive pulley (1a, 1b, 1c).
16. Lift installation according to claim 14 or 15, characterised in that the axes of the drive pulleys (1a, 1b, 1c) lie parallel to the first and the second shaft wall.
17. Lift installation according to any one of the preceding claims, characterised in that a

counterweight (12a, 12b, 12c) is associated with each lift cage (7a, 7b, 7c).

18. Lift installation according to claim 17, characterised in that each counterweight (12a, 12b, 12c) is guided by two counterweight guide rails (11a.1, 11a.2, 11b.1, 11b.2).

19. Lift installation according to claim 17 or 18, characterised in that each lift cage (7a, 7b, 7c) is movable along two cage guide rails (10.1, 10.2).

20. Lift installation according to claim 18 or 19, characterised in that the counterweights (12a, 12b, 12c) are positionable between the cage guide rails (10.1, 10.2) and first or second shaft walls.

21. Lift installation according to any one of claims 17 to 20, characterised in that at least one tension means (Z1, Z2, Z3) is associated with each lift cage (7a, 7b, 7c).

22. Lift installation according to claim 21, characterised in that the lift cage (7a, 7b, 7c) and the associated counterweight (12a, 12b, 12c) are suspended at a common tension means (Z1, Z2, Z3).

23. Lift installation according to claim 21 or 22, characterised in that the tension means (Z1, Z2, Z3) are disposed in operative contact with the drive pulley (1a, 1b, 1c).

24. Lift installation according to any one of claims 21 to 23, characterised in that the lift cages (7a, 7b, 7c) are suspended at the tension means (Z1, Z2, Z3) in block-and-tackle manner.

25. Lift installation according to claim 24, characterised in that the lift cages (7a, 7b, 7c) each have at least one first and second deflecting roller (2a, 2b, 2c, 3a, 3b, 3c) mounted in the lower region of the lift cages (7a, 7b, 7c).

26. Lift installation according to claim 25, characterised in that the tension means (Z1, Z2, Z3) are guided by the drive pulleys (1a, 1b, 1c) and the first and second deflecting rollers (2a, 2b, 2c, 3a, 3b, 3c) to first fixing points (5a, 5b, 5c).

27. Lift installation according to any one of claims 21 to 26, characterised in that the

counterweights (12a, 12b, 12c) are suspended below the associated drives (A1, A2, A3) in block-and-tackle manner at the tension means (Z1, Z2, Z3).

28. Lift installation according to claim 27, characterised in that the counterweights (12a, 12b, 12c) have third deflecting rollers (4a, 4b, 4c) fixed in the upper region of the counterweights (12a, 12b, 12c).

29. Lift installation according to claim 28, characterised in that the tension means (Z1, Z2, Z3) are guided by the drive pulleys (1a, 1b, 1c) via the third deflecting rollers (4a, 4b, 4c) to second fixing points (6a, 6b, 6c).

30. Lift installation according to any one of claims 21 to 29, characterised in that the tension means (Z1, Z2, Z3) consist of at least one cable or double cable.

31. Lift installation according to any one of claims 21 to 29, characterised in that the tension means (Z1, Z2, Z3) consist of at least one belt.

32. Lift installation according to claim 30 or 31, characterised in that the supporting structure of the tension means (Z1, Z2, Z3) is formed from aramide fibres or Vectran fibres.

33. Lift installation according to claim 32, characterised in that the belts are structured at one side.

34. Lift installation according to claim 31 or 33, characterised in that the belts are cogged belts or wedge-ribbed belts.

35. Lift installation according to claim 33 or 34 in combination with one of claims 26 and 29, characterised in that the belts are guided by the drive pulleys (1a, 1b, 1c) and at least first deflecting rollers (2a, 2b, 2c), second deflecting rollers (3a, 3b, 3c) and third deflecting rollers (4a, 4b, 4c), only one side of the belt is disposed in contact with the drive pulleys (1a, 1b, 1c) and deflecting rollers (2a, 2b, 2c, 3a, 3b, 3c, 4a, 4b, 4c) and the belts are turned through 180° about the respective longitudinal axis thereof between the drive pulleys (1a, 1b, 1c) and the first deflecting rollers (2a, 2b, 2c).

36. Lift installation according to claim 19 in combination with claim 25, characterised in that the cage guide rails (10.1, 10.2) form a connecting plane (V) and the tension means (Z1, Z2, Z3), the drive pulleys (1a, 1b, 1c) and the first and second deflecting rollers (2a, 2b, 2c, 3a, 3b, 3c) of the associated lift cage (7a, 7b, 7c) are arranged at one side of the connecting plane (V).

37. Lift installation according to claim 19 in combination with claim 25, characterised in that the lift cages (7a, 7b, 7c) are guided by two cage guide rails (10.1, 10.2), wherein these cage guide rails (10.1, 10.2) form a connecting plane (V) and the tension means (Z1, Z2, Z3), the drive pulleys (1a, 1b, 1c) and the first and second associated deflecting rollers (2a, 2b, 2c, 3a, 3b, 3c) of the associated lift cage (7a, 7b, 7c) are arranged at both sides of the connecting plane (V).

38. Lift installation according to one of the preceding claims, characterised in that each drive (A1, A2, A3) is fixed on a crossbeam (19).

39. Lift installation according to claim 38 in combination with claim 18 or 19, characterised in that the crossbeam (19) is fastened to the cage guide rails (10.1) and/or to the counterweight guide rails (11a.1, 11a.2).