

Lift with two lift cages disposed one above the other in a shaft

The invention relates to a lift with at least two lift cages which are arranged one above the other and vertically movable in a shaft. This invention is defined in the introductory part of the independent patent claim.

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.

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 tension means 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 task of the present invention is to further improve the arrangement of lift components for the vertical movement of several lift cages in a lift shaft.

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

The lift according to the invention comprises at least two lift cages which are disposed one above the other and vertically movable in a shaft independently of one another. The lift cages each have an own drive with at least one motor and at least one drive pulley, an own counterweight and at least one own tension means. A drive is fixed to a first shaft wall and a further drive is fixed to an opposite second shaft wall. The drives can be moved past by the lift cages and the motors of the drives are arranged vertically above the associated drive pulleys.

The advantage of the lift resides in the space-saving arrangement of the drives at first and second shaft walls. The drives lie in the region of the clear profiles of the counterweight and thus do not occupy any additional space in the shaft head or in the shaft pit. Such an arrangement of the drives is thus particularly space-saving.

Advantageously the drives are positioned alternately on opposite shaft walls at two different shaft heights, wherein the spacing between two drives of lift cages arranged one above the other advantageously amounts to at least one cage height.

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.

Advantageously the axes of the drive pulleys lie parallel to the first and second shaft wall.

The advantage of the lift is that the tension means, which are in contact with the drive pulleys, can be guided from the first shaft walls to the second shaft walls directly without horizontal change in direction.

Advantageously the lift cages are suspended in block-and-tackle manner and have at least two deflecting rollers, which are mounted in the lower region of the lift cages. Equally advantageously the counterweights are suspended below the associated drives in block-and-tackle manner and the counterweights have third deflecting rollers which are fixed in the upper region of the counterweights.

The advantage of the lift resides in the 2:1 suspension of the lift cages and the counterweights. Thanks to this suspension the drive only has to produce half as much drive torque and can be of correspondingly more compact construction and occupy less space in the lift shaft.

Advantageously the lift cages are guided by two cage guide rails and the counterweights are positionable between cage guide rails and first or second shaft walls.

The advantage of the lift resides in the simple and space-saving arrangement of the counterweights.

Advantageously the tension means consist of at least one cable, double cable or belt. Equally advantageously the load-bearing structure of the tension means is formed from aramide fibres or Vectran fibres.

The advantage of the lift resides in the use of favourable standard tension means. The use of high-strength synthetic fibres is additionally distinguished, by comparison with traditional steel fibres, by an improved ratio of tensile strength to intrinsic weight.

Advantageously the belts are structured at one side, such as, for example, cogged belts or wedge-ribbed belts structured at one side. Such belts are advantageously guided by the drive pulleys and at least first, second and third deflecting rollers, in which case

advantageously only one side of the belt is disposed in contact with the drive pulleys and deflecting rollers. This is due to the fact that the belts are turned through 180° about their respective longitudinal axis between the drive pulleys and the first deflecting rollers.

The advantage of the lift is that belts structured at one side can be produced as standard and are advantageous. Thanks to the turning through 180° between the drive pulley and the first deflecting roller these belts are always bent in the same sense around the deflecting rollers and drive pulleys. This increases the service life of the belts and reduces the maintenance costs of the lift.

Advantageously the lift cages are guided by two cage guide rails, wherein these cage guide rails form a connecting plane and the tension means, the drive pulleys as well as the first and second deflecting rollers of the associated lift cage are arranged at one side of the connecting plane.

The advantage of the lift resides in the use of drive pulleys and deflecting rollers with several grooves arranged in parallel. Such drive pulleys and deflecting rollers accept several tension means. Depending on the respective need, several tension means, which are associated with a lift cage, can thus be guided in simple manner parallel adjacent to one another.

Optionally the lift cages are advantageously guided by two cage guide rails, wherein these cage guide rails form a connecting plane and the tension means, the drive pulleys as well as the first and second associated deflecting rollers of the associated lift cage are arranged on both sides of the connecting plane.

The advantage of the lift is the symmetrical suspension at the centre of gravity of the lift cages. Since the cage guide rails usually similarly guide the lift cage at the centre of gravity of the lift cage, no additional forces and moments are introduced into the cage guide rails with such a suspension.

Advantageously each drive is fixed on a crossbeam fastened to the cage guide rails and/or to the counterweight guide rails.

The advantage of the lift according to the invention is fixing the drives as simply as

possible in the shaft space and fully utilising the structures present.

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

- Fig. 1 shows a schematic side view of an arrangement of a lift with two lift cages, two drives, two drive pulleys, two tension means and several deflecting rollers;
- Fig. 2 shows a schematic plan view of an arrangement of a lift with two lift cages as well as two drives, two drive pulleys, two tension means and several deflecting rollers, which each lie on one side of the connecting plane formed by two cage guide rails;
- Fig. 3 shows a schematic plan view of an arrangement of a lift with two lift cages as well as two drives, two drive pulleys, two tension means and several deflecting rollers, which respectively lie on either side of the connecting plane formed by two cage guide rails; and
- Fig. 4 shows a side view of an arrangement of the drives on crossbeams in the shaft.

Figure 1 shows a lift with at least two lift cages 7a, 7b, which each have an own drive A1, A2 and are movable independently of one another in vertical direction. The drives A1, A2 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. In that case the drives A1, A2 are disposed in alternation on opposite shaft walls at two different shaft heights, wherein as a rule the distance in vertical direction amounts to at least one cage height. The drives A1, A2 define by their position at the same time the highest reachable point of an associated lift cage 7a, 7b, since the tension means in the illustrated form of embodiment cannot raise a suspension point of a lift cage 7a, 7b above the height of a drive pulley 1a, 1b. However, it is also conceivable for two drives A1, A2 of adjacent lift cages 7a, 7b to be fixed at the same shaft height.

The drive A1, A2 has a motor M1, M2, as shown in Fig. 4, preferably an electric motor, a

drive pulley 1a, 1b and optionally a setting pulley 13a, 13b by which the looping angle of the tension means Z1, Z2 around the drive pulley 1a, 1b and the horizontal spacing of the tension means Z1, Z2 from the drive A1, A2, from the lift cage 7a, 7b or from the counterweight 12a, 12b can be set.

The motor M1, M2 lies vertically above the drive pulley 1a, 1b. Thanks to this arrangement the drive A1, A2 can be positioned in the clear projection of the counterweights 12a, 12b between the lift cages 12a, 12b and first and second shaft walls. The drives A1, A2 can thereby be moved past by the lift cages 7a, 7b and thus can be mounted in an otherwise unneeded space of the shaft. By comparison with conventional lifts without engine rooms space is thereby gained in the shaft head and/or in the shaft pit.

The motor M1, M2 of the drive A1, A2 drives the tension means Z1, Z2 via drive pulley 1a, 1b. The drive pulley 1a, 1b is so designed that it is suitable for accepting one or several tension means Z1, Z2. The tension means Z1, Z2 are preferably belts such as wedge-ribbed belts with ribs at one side, which engage in one or several depressions at the drive pulley side. Belt variants such as smooth belts and belts which are toothed at one side or both sides are, with corresponding drive pulleys 1a, 1b, similarly usable. In addition, different kinds of cables, such as single cables, double cables or multiple cables, are also usable. The tension means comprise strands of steel wire or aramide or Vectran.

The at least two lift cages 7a, 7b and two counterweights 12a, 12b are suspended at the tension means Z1, Z2 in block-and-tackle manner. In that case the lift cages have at least one first and second deflecting roller 2a, 2b, 3a, 3b, which are fastened in the lower region of the lift cages 7a, 7b. These deflecting rollers 2a, 2b, 3a, 3b have at the outer circumference one of several grooves which are such that they can receive one or more tension means Z1, Z2. The deflecting rollers 2a, 2b, 3a, 3b are thus suitable for guidance of tension means Z1, Z2 and are brought into contact with the latter. The lift cages 7a, 7b are 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 suspended as an upper block and tackle.

A third deflecting roller 4a, 4b, which is similarly suitable analogously to the deflecting

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

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

From the first fixing point 5a, 5b the tension means Z1, Z2 extends along a first or second shaft wall downwardly to the second deflecting roller 3a, 3b, loops around this from the outside to the inside at an angle of approximately 90° and leads to the first deflecting roller 2a, 2b. The tension means Z1, Z2 loops around this first deflecting roller 2a, 2b from the inside to the outside again through approximately 90° and is thereafter led upwardly along the lift cage 7a, 7b to the drive pulley 1a, 1b and loops around this from the inside to the outside through approximately 150° . Depending on the respective setting of the optional setting pulley 13a, 13b the looping angle can be varied in a range of 90 to 180° . Thereafter, the tension means Z1, Z2 is led along a second or first shaft wall downwardly to the third deflecting roller 4a, 4b, loops around this from the outside to the inside through approximately 180° and is led upwardly back along a second or first shaft wall to the second fixing point 6a, 6b.

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

According to Fig. 2 the lift cages 7a, 7b 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 approximately extends through the centre of gravity S of each of the two lift cages 7a, 7b. In the illustrated form of embodiment the lift cages 7a, 7b are eccentrically suspended. The tension means Z1, Z2 and the associated drive means, such as deflecting rollers 2a, 2b, 3a, 3b, 4a, 4b and drive pulleys 1a, 1b, in this suspension arrangement lie at one side of the connecting plane V, wherein the deflecting rollers 4a, 4b are, for the sake of clarity, not illustrated in Fig. 2, i.e. all afore-mentioned components associated with a lift cage 7a, 7b 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. Advantageously the spacing y of the tension means Z1, Z2 and the connecting plane V is approximately the same. The tension means Z1, Z2 of a lift cage 7a, 7b lie in alternation on one or the other side of the connecting plane V. Thus, the moments which are generated by the eccentric suspension of the lift cages 7a, 7b counteract one another. In the case of an equal rated load of the lift cages 7a, 7b and in the case of an even number of lift cages 7a, 7b, the moments acting on the guide rails 10.1, 10.2 substantially cancel one another.

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

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

With knowledge of this form of embodiment numerous possibilities of variation are open to the expert depending on the respectively set task. Thus, the expert 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, according to the respective design, receive one to four or, in the case of need, also more tension means Z1, Z2.

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

Fig. 3 shows an alternative suspension arrangement with centrally suspended lift cages 7a, 7b. In that case the tension means Z1, Z2 are guided by the deflecting rollers 2a, 2b, 3a, 3b, 4a, 4b and drive pulleys 1a, 1b at both sides of the connecting plane V. Advantageously, in that case the suspension is 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 of the lift cage 7a, 7b, no additional moments act on the cage guide rails 10.1, 10.2.

In this central suspension of the lift cages 7a, 7b 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, which are arranged on the left and right of the connecting plane V. The deflecting rollers 4a, 4b of the counterweights 12a, 12b similarly consist of two rollers which are arranged on the left and right of the connecting plane V, but for the sake of clarity are not illustrated in Fig. 3. In the present example the deflecting rollers 2a, 3a, 4b and the drive pulley 1a associated with the upper lift cage 7a lie at a first spacing x from the connecting plane V and the deflecting rollers 2b, 3b, 4b and the drive pulley 1b associated with the upper lift cage 7a lie 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 is thereby guaranteed in the case of central suspension of the lift cages 7a, 7b.

Here, too, the counterweights 12a, 12b are advantageously suspended at their centre of gravity at the tension means Z1, Z2 between the cage guide rails 10.1, 10.2 and first or

second shaft walls. Since the lift cages 7a, 7b are now centrally suspended, the counterweights 12a, 12b also lie in a middle region of the first and second shaft walls. Thanks to this central position of the counterweights 12a, 12b the free space between the lateral ends of the counterweights 12a, 12b and third and fourth shaft walls increases. Design freedom for the counterweights 12a, 12b is thereby gained. Thus, for example, a narrower and wider counterweight 12a, 12b can be used in order to better utilise the space. For a given shaft cross-section, the lift cage 7a, 7b gains width or for a given lift cage size the shaft cross-section can be reduced.

Fig. 4 shows a drive A1 which is fixed on a crossbeam 19 fastened to a cage guide rail 10.1 and/or to the counterweight guide rails 11a.1, 11a.2. There can also be seen in Fig. 4: the motor M1 with drive pulley 1a arranged thereunder and optional setting pulley 13a, 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 by comparison with the arrangement of Fig. 2 with respect to the connecting plane V.

The drives A1, A2 can optionally also be directly fixed to the shaft walls and the crossbeam 19 saved.

Claims

1. Lift with at least two lift cages (7a, 7b), which are disposed one above the other and are vertically movable in a shaft independently of one another and which each have an own drive (A1, A2) with at least one motor and at least one drive pulley (1a, 1b), an own counterweight (12a, 12b) and at least one own tension means (Z1, Z2), a drive (A1) is fixed to a first shaft wall and a further drive (A2) is fixed to an opposite second shaft wall and the drives (A1, A2) can be moved past by the lift cages (7a, 7b), characterised in that the motors of the drives (A1, A2) are arranged vertically above the associated drive pulleys (1a, 1b).
2. Lift according to claim 1, characterised in that the drives (A1, A2) are positioned alternately on opposite first and second shaft walls at two different shaft heights.
3. Lift according to claim 2, characterised in that the spacing between drives (A1, A2) of the lift cages (7a, 7b) disposed one above the other amounts to at least a cage height.
4. Lift according to any one of the preceding claims, characterised in that the axes of the drive pulleys (1a, 1b) lie parallel to the first and second shaft wall.
5. Lift according to any one of the preceding claims, characterised in that the lift cages (7a, 7b) are suspended in block-and-pulley manner.
6. Lift according to claim 5, characterised in that the lift cages (7a, 7b) each have at least two deflecting rollers (2a, 2b, 3a, 3b) mounted in the lower region of the lift cages (7a, 7b).
7. Lift according to claim 5, characterised in that the lift cages (7a, 7b) each have at least two deflecting rollers (2a, 2b, 3a, 3b) mounted in the upper region of the lift cages (7a, 7b).
8. Lift according to claim 7, characterised in that the tension means (z1, z2) are guided by the drive pulleys (1a, 1b) and the first and second deflecting rollers (2a, 2b, 3a, 3b) to first fixing points.

9. Lift according to any one of the preceding claims, characterised in that the counterweights (12a, 12b) are suspended below the associated drives (A1, A2) in block-and-pulley manner.
10. Lift according to claims 9, characterised in that the counterweights (12a, 12b) have third deflecting rollers (4a, 4b) fixed in the upper region of the counterweights (12a, 12b).
11. Lift according to claim 10, characterised in that the tension means (Z1, Z2) are guided by the drive pulleys (1a, 1b) via the third deflecting rollers (4a, 4b) to second fixing points (6a, 6b).
12. Lift according to claim 11, characterised in that the counterweights (12a, 12b) are each guided by two counterweight guide rails (11a.1, 11a.2, 11b.1, 11b.2).
13. Lift according to any one of the preceding claims, characterised in that the lift cages (7a, 7b) are guided by two cage guide rails (10) and that the counterweights (12a, 12b) are positionable between cage guide rails (10) and first or second shaft walls.
14. Lift according to any one of the preceding claims, characterised in that the tension means (Z1, Z2) consist of at least one cable or double cable.
15. Lift according to any of claims 1 to 13, characterised in that the tension means (Z1, Z2) consist of at least one belt.
16. Lift according to claim 14 or 15, characterised in that the supporting structure of the tension means (Z1, Z2) is formed from aramide or Vectran fibres.
17. Lift according to claim 15, characterised in that the belts are structured at one side.
18. Lift according to claim 15 or 17, characterised in that the belts are cogged belts or wedge-ribbed belts.
19. Lift according to claim 14, 17 or 18, characterised in that the belts are guided by the drive pulleys (1a, 1b) and at least first (2a, 2b), second (3a, 3b) and third (4a, 4b) deflecting rollers, only one side of belts is in contact with the drive pulleys (1a, 1b) and

deflecting rollers (2a, 2b, 3a, 3b, 4a, 4b) and that the belts are turned through 180° about their respective longitudinal axis between the drive pulleys (1a, 1b) and the first deflecting rollers (2a, 2b).

20. Lift according to any one of the preceding claims, characterised in that the lift cages (7a, 7b) are guided by two cage guide rails (10), wherein these cage guide rails (10) form a connecting plane and the tension means (Z1, Z2), the drive pulleys (1a, 1b) as well as the first and second deflecting rollers (2a, 2b, 3a, 3b) of the associated lift cage (7a, 7b) are arranged at one side of the connecting plane.

21. Lift according to any one of claims 1 to 19, characterised in that the lift cages (7a, 7b) are guided by two cage guide rails (10), wherein these cage guide rails (10) form a connecting plane and the tension means (Z1, Z2), the drive pulleys (1a, 1b) as well as the first and second associated deflecting rollers (2a, 2b, 3a, 3b) of the associated lift cage (7a, 7b) are arranged on both sides of the connecting plane.

22. Lift according to any one of the preceding claims, characterised in that each drive (A1, A2) is fixed on a crossbeam (19) fastened to the cage guide rails (10) and/or to the counterweight guide rails (11a.1, 11a.2, 11b.1, 11b.2).