

Method for measuring an elevator shaft, control unit for a self-climbing lift and self-climbing lift

5 The present invention relates to a method for measuring an elevator shaft by means of a concomitantly rising self-climbing lift, a control unit for the concomitantly rising self-climbing lift, and the concomitantly rising self-climbing lift. The present invention relates in particular to a method for measuring the elevator shaft by means of the concomitantly rising self-climbing lift, the control unit that performs the method, and the concomitantly rising self-climbing lift designed for measuring the elevator shaft.

10 A self-climbing lift, also called a concomitantly rising elevator system or jump lift, can be used during the construction of a building to transport persons and/or loads from one existing floor of the building to another existing floor of the building in an elevator shaft of the building that has been started but not yet completed. This operating mode of the self-climbing lift can also be referred to as the “normal” mode or transport mode of the self-climbing lift. With the increasing height of the building, components of the self-climbing lift arranged above can then be positioned progressively higher within the elevator shaft, which can also be referred to as the self-climbing mode of the self-climbing lift, until the elevator shaft is completed and the self-climbing lift can be replaced by a “normal” lift.

20 Such a self-climbing lift is known, for example, from EP 3 548 413 B1. The self-climbing lift has a protective platform, a machine platform, and an assembly platform. The protective platform can be inserted into the elevator shaft, which is still open at the top, by means of a crane. The protective platform is permanently arranged in the elevator shaft during normal operation of the self-climbing lift. The machine platform is suspended in the elevator shaft by means of a support means on the protective platform in such a way that the machine platform can be relocated vertically in the elevator shaft by means of the support means. For this purpose, the self-climbing lift has a relocation device which can be arranged on the machine platform and which is mechanically coupled to the support means in such a way that the relocation device can relocate the support means, whereby the machine platform is displaced vertically. An assembly platform can be arranged between the protective platform and the machine platform. The assembly platform is held by the protective platform by means of an additional

support means. The assembly platform is in particular suspended in the elevator shaft in such a way that it can be relocated vertically, in particular by means of an additional relocating device that is coupled to the additional support means. The assembly platform can be used by a technician to carry out assembly work vertically in the elevator shaft between the machine platform and the protective platform.

WO 2020/126906 A1 describes a construction site device with a climbing framework platform and an elevator system. The construction site device has a 3D camera or 3D scanner by means of which optical images of rebar introduced in a future wall region can be taken.

Among other things, there can be a need for a method for measuring an elevator shaft that makes it possible to check, already during the construction of a building that has at least a partially completed elevator shaft, whether the elevator shaft and/or elevator components that are arranged in the elevator shaft have been installed as intended, properly and/or correctly, and/or that allows for the simplification and/or automation of the completion of the building, in particular the elevator shaft, and/or subsequent installation and/or service work. Furthermore, there can be a need for a control unit for a concomitantly rising self-climbing lift that executes the method. Furthermore, there can be a need for a concomitantly rising self-climbing lift that allows for verification, already during the construction of the building that has at least a partially completed elevator shaft, whether the elevator shaft and/or elevator components that are arranged in the elevator shaft have been installed as intended, properly and/or correctly, and/or that allows for the simplification and/or automation of the completion of the building, in particular the elevator shaft, and/or subsequent installation and/or service work.

Such a need can be met by the subject matter in accordance with the independent claim. Advantageous embodiments are defined in the dependent claims and in the following description.

A first aspect of the invention relates to a method for measuring an elevator shaft by means of a concomitantly rising self-climbing lift for transporting a load from one floor to another floor within a building under construction, wherein the self-climbing lift has a platform that is temporarily arranged in the elevator shaft. The method involves: recording at least one measured value representative of a property of the elevator shaft

by means of a sensor that is fastened to the platform while the platform is relocated;
and creating a digital model of the elevator shaft based on the detected measured value.

5 A second aspect of the invention relates to a control unit for the concomitantly rising
self-climbing lift for erecting the self-climbing lift having an elevator shaft for
transporting a load from one floor to another floor within a building under construction.
The control unit has: a storage unit for storing the at least one measured value that is
representative of the property of the elevator shaft; and a processor that is designed to
execute the method described above and below.

10 A third aspect of the invention relates to the self-climbing lift in the form of a growing self-
climbing lift having an elevator shaft for transporting a load from one floor to another floor
within a building under construction. The self-climbing lift has: a first platform which is
arranged to be movable in the elevator shaft; a second platform which is mechanically
15 coupled to the first platform by means of a first support means and which is movably
arranged in the elevator shaft below the first platform; the at least one sensor which is
arranged on one of the platforms and which is designed in such a way that the measured value
can be detected by means of the sensor, which measured value is representative of the
property of the elevator shaft while the corresponding platform is being relocated; and the
20 control unit described above and below, which is communicatively coupled with the sensor.

The elevator shaft is located inside a building. The building, and in particular the
elevator shaft, may still be under construction, and accordingly, the building and the
elevator shaft may not yet be completed. The elevator shaft can extend vertically within
25 the building, for example. In this case, moving the platform within the elevator shaft
refers to a vertical relocation of the platform within the elevator shaft.

The self-climbing lift can also be referred to as a concomitantly rising elevator system.
The self-climbing lift can be used during the construction of the building to transport
30 persons and/or loads in the elevator shaft from one floor of the building to another floor
of the building, which has been started but is not yet completed. This operating mode of
the self-climbing lift can also be referred to as the “normal” mode or transport mode of
the self-climbing lift. With the increasing height of the building, components of the self-
climbing lift arranged above can then be positioned progressively ever higher within the

elevator shaft, which can also be referred to as the self-climbing mode of the self-climbing lift, until the elevator shaft is completed and the self-climbing lift can be replaced by a “normal” elevator. Components of the self-climbing lift such as the mentioned platforms are removed when the self-climbing lift is replaced with a “normal” elevator so that they are only temporarily arranged in the elevator shaft. The measured value can be detected during transport mode and/or during self-climbing mode.

Capturing the measured value while the corresponding platform is being relocated makes it possible to automatically record the measured value while the corresponding platform is being relocated. Preferably, the measured value is detected several times during the relocation of the platform, for example continuously, wherein a measured signal that is detected by the sensor can then be representative of a course of the measured value. This repeated recording of the measured value makes it possible to measure the elevator shaft – insofar as it is completed – in particular to determine its properties. Therefore, no separate work step is needed to measure the elevator shaft since this happens automatically when the platform is relocated, and the elevator shaft is completely measured at the latest when the self-climbing lift is removed from the building. A subsequent, conventional measurement of the elevator shaft is then unnecessary. This makes it possible to check, even during the construction of the building, which has at least a partially completed elevator shaft, whether the elevator shaft and/or elevator components that have already been arranged in the elevator shaft have been installed as intended, properly and/or correctly. Alternatively or additionally, this early measurement of the elevator shaft can make it possible to simplify and/or automate the completion of the building, in particular the elevator shaft, and/or subsequent installation and/or service work.

In addition to the single measured value, a number of additional measured values can be detected, in particular while the corresponding platform is being relocated. The additional measured values can refer to the same property. Alternatively or additionally, two or more first measured values can refer to a first property of the elevator shaft, and one, two or more second measured values can refer to a second property of the elevator shaft. Accordingly, during the relocation of the corresponding platform, two or more properties of the elevator shaft can be determined by means of recording corresponding first and second or corresponding additional measured values and/or by means of corresponding first and second measured value trends.

The detected measured values can together form the digital model of the elevator shaft. The digital model can therefore comprise a digital data set in which several additional measured values are encoded in addition to the one measured value. The digital model of the elevator shaft is representative of the fully measured elevator shaft. The digital model of the elevator shaft can also be stored on the storage unit.

It is also possible for the digital model to be created from the measuring signals in a subsequent step, independently of the control unit of the self-climbing lift. The detected measured values can be transmitted to another evaluation unit, for example via the Internet.

The property of the elevator shaft to be recorded can be, for example, its height, width, depth, or length of the elevator shaft. The property to be recorded for the elevator shaft can also be the position of a single point or the positions of several points on a shaft wall of the elevator shaft. The digital model of the elevator shaft can therefore be formed from a so-called point cloud.

The property to be recorded can also refer to the positions and/or sizes of one or more elevator components that are permanently arranged in the elevator shaft. Accordingly, within the meaning of this description, not only the shaft walls of the elevator shaft are assigned thereto, but also elevator components that are permanently installed in the elevator shaft. These elevator components can, for example, have or be clamps, brackets, supports, angles and/or guide rails. The measured value that is representative of the property can therefore be, for example, the height, width, depth or length of the elevator shaft.

The method can be executed entirely or partially by the control unit of the self-climbing lift. For this purpose, the control unit can optionally send a relocation signal to the unit that is responsible for moving the platform having the sensor. For example, if the platform having the sensor is a protective platform for the self-climbing lift, it can be relocated by means of a crane external with reference to the self-climbing lift, and the relocation signal can be sent to a crane controller of the crane. For example, if the platform containing the sensor is a machine platform or an installation platform of the self-climbing lift, the control unit can send the relocation signal to a relocation device of the self-climbing lift, for example in the form of a winch, which is responsible for relocating the machine platform or the installation platform. Furthermore, the control unit can send the detection signal to the sensor which

then records the measured value in response to receiving the detection signal. As a result, the control unit can receive the measuring signal from the sensor, which measuring signal the sensor has generated and which is representative of the measured value. Furthermore, the digital model can be determined by means of the control unit.

5

The first platform can also be called a protective platform. The first platform can be relocated by means of the crane, for example, during the self-climbing mode of the self-climbing lift. The self-climbing lift can have two or more platforms, which will be explained in more detail below. The second platform could be, for example, a machine platform or an installation platform for the self-climbing lift. The second platform can be relocated, for example, by means of a relocation device of the self-climbing lift, for example during transport mode or during the self-climbing mode of the self-climbing lift. If the self-climbing lift has the machine platform and the installation platform, one of the two platforms can be suspended from the protective platform by means of the first support means, and the other of the two platforms can be suspended from the protective platform by means of a second support means. Alternatively, the machine platform and the installation platform can be suspended from the protective platform by means of the first support means, wherein the machine platform can be suspended from the protective platform by means of a first section of the first support means, the installation platform can be suspended from the protective platform by means of a second section of the first support means, and the first and second sections can be separated from each other by a deflection pulley over which the first support means is deflected.

10

15

20

25

30

The self-climbing lift can additionally have, for example, an elevator car, a counterweight, a first relocation device and optionally a second relocation device and/or a drive machine. The elevator car can serve to carry one or more persons and/or loads during normal mode of the self-climbing lift. The elevator car can, for example, be suspended vertically relocatable below the machine platform, for example by means of a third support means that is mechanically coupled to the machine platform. The counterweight can be arranged in the elevator shaft and serve to vertically relocate and/or hold the elevator car. The counterweight can, for example, be mechanically coupled to the elevator car via the third support means. For example, the third support means can run from the counterweight via one or more deflection pulleys that are arranged on the machine platform to the elevator car.

The first relocation device can, for example, be mechanically coupled to the first support means and serve to move the first support means, which allows the machine platform and/or the installation platform to be relocated vertically. If the installation platform can be relocated vertically independently of the machine platform by means of the second support means, then the second support means can be relocated by means of the second relocating device in order to relocate the installation platform vertically. The drive machine can, for example, be mechanically coupled to the third support means and serve to relocate the third support means, which allows the elevator car to be relocated vertically.

The self-climbing lift can assume various operating states. For example, in a first operating state, the protective platform and the machine platform can be permanently arranged in their vertical positions in the elevator shaft so that they cannot be relocated vertically in the first operating state. In the first operating state, the elevator car can be relocated vertically below the machine platform, for example to transport persons and/or loads. Furthermore, in the first operating state, the installation arrangement can be relocated vertically. The first operating state represents the “normal” mode of the self-climbing lift, which can also be referred to as the transport mode of the self-climbing lift. In a second operating state, the protective platform can be permanently arranged in its vertical position in the elevator shaft, and the machine platform can be relocated vertically, for example by means of the first support means and the first relocation device. In a third operating state, the protective platform can be relocated vertically. For this purpose, the protective platform can be mechanically coupled to a crane external with respect to the self-climbing lift via the elevator shaft, which is still open at the top, and relocated vertically within the elevator shaft by means of the crane. The third operating state represents the self-climbing mode of the self-climbing lift.

According to one embodiment, the platform having the sensor is relocated during the self-climbing mode of the self-climbing lift, for example in response to receiving the relocation signal, the detection signal is sent to the sensor during the self-climbing mode, and the sensor is designed to record the measured value during the self-climbing mode. This makes it possible to measure the elevator shaft before the transport mode of the self-climbing lift since the self-climbing mode is first needed to position the self-climbing lift and in particular the platform in the region in which the transport mode is to take place. Optionally, the elevator shaft can already be measured and, in particular, the measured value can be detected when the

self-climbing lift and in particular the platform are lowered into the elevator shaft from above for the first time by means of the external crane. This allows the elevator shaft to be measured already before the self-climbing mode and before the transport mode. For example, the crane could be a construction crane used in the construction of the building.

5

According to one embodiment, the self-climbing lift has: a protective platform which forms the first platform; and a machine platform which forms the second platform and which is mechanically coupled to the first support means in such a way that the machine platform can be relocated vertically in the elevator shaft by means of the first support means. The sensor can be arranged, for example, on one of the platforms such as the protective platform or on the machine platform. Arranging the sensor on the protective platform or the machine platform makes it possible to record the property and, in particular, the measured value during the self-climbing mode of the self-climbing lift since the protective platform and/or the machine platform are relocated vertically during the self-climbing mode. The machine platform can be relocated, for example, by means of the first relocation device of the self-climbing lift, which is mechanically coupled to the first support means. The first relocation device can, for example, be arranged on the machine platform. However, it can also be arranged on the protective platform.

20 In accordance with one embodiment, the sensor is arranged on the protective platform. This can help to record the property and, in particular, the measured value as early as possible since the protective platform is relocated as the first platform of the self-climbing lift, in particular during the self-climbing mode of the self-climbing lift and/or when the self-climbing lift is first arranged in the elevator shaft.

25

In accordance with one embodiment, the sensor is arranged on the machine platform. This can help allow the property and in particular the measured value to be recorded early on since the machine platform is relocated during the self-climbing mode of the self-climbing lift and/or when the self-climbing lift is first arranged in the elevator shaft.

30

According to one embodiment, the self-climbing lift has: the protective platform which forms the first platform; the machine platform which is arranged in the elevator shaft below the protective platform and is mechanically coupled to the first support means in such a way that the machine platform can be relocated vertically in the elevator shaft by

means of the first support means; and the installation platform which forms the second platform and is suspended from the protective platform between the protective platform and the machine platform in the elevator shaft in such a way as to be relocated vertically, wherein the sensor is arranged on the installation platform.

5

Arranging the sensor on the installation platform makes it possible to record the property and, in particular, the measured value during the transport mode of the self-climbing lift. The installation platform can, for example, serve to carry out installation work vertically between the protective platform and the machine platform. These installation works can be carried out, for example, by means of a mechatronic installation device, such as an industrial robot, or by an installer. The installation work can be carried out during the transport mode of the self-climbing lift. During the transport mode, the protective platform and the machine platform are secured in a vertical direction and are not relocated vertically.

10

15

According to one embodiment, the sensor has a detection region within which the measured value can be detected, and the sensor is arranged on the corresponding platform in such a way that the detection region is directed outwards with respect to the corresponding platform. The fact that the detection region is directed outwards with respect to the corresponding platform can mean that the detection region is directed towards a shaft wall of the elevator shaft. This makes it possible to detect the property of the shaft wall or one of the elevator components that is arranged on the shaft wall by means of the sensor. Accordingly, the property of the elevator shaft to be determined by means of the sensor can be a property of the shaft wall or of the elevator component fastened to the shaft wall. The detection region can also be referred to as the operational detection region. If the sensor is an optical sensor, such as a camera, then the detection region can be, for example, the field of view or the angle of view of the camera.

20

25

According to one embodiment, the sensor is arranged in such a way that it is movable and that the detection region can therefore be changed. For example, a scanning movement can be performed by means of the sensor, which allows a region of the elevator shaft to be scanned by means of the sensor that is larger than the detection region of the sensor. A scan direction in which the sensor can be moved can be at least partially horizontally oriented so that the elevator shaft can be scanned in a horizontal direction by means of the scanning movement and in a vertical direction by means of relocating the corresponding platform. When determining the property and/or when correspondingly recording the

30

measured value, the sensor can be rotated, for example by 360°, for example by a vertical axis of rotation, so that a horizontal region around the sensor can be scanned with the sensor. In other words, the scanning movement can be a rotational movement.

Alternatively, the scanning movement can have a vertical component in addition to the horizontal component. For example, the scanning movement can be meandering.

According to one embodiment, the self-climbing lift has at least one additional sensor which is arranged on the same platform as the sensor and which is oriented in such a way that an additional detection region of the additional sensor is a different region than the detection region of the sensor. For example, the additional detection region of the additional sensor can be directed in a different direction than the detection region of the sensor. Optionally, three or more additional sensors, for example four, can be arranged on the corresponding platform whose additional detection regions differ at least partially from each other. For example, the additional sensors can be arranged so that their detection regions overlap each other in the horizontal direction so that the elevator shaft can be scanned all around by means of the sensors. In the case of four sensors, their additional detection regions can each be directed towards one of the shaft walls of the elevator shaft so that all four shaft walls can be scanned simultaneously by means of the sensors. As an alternative to these several additional sensors, a single sensor can be rotatably arranged on the corresponding platform so that the elevator shaft can be scanned all around by means of the one rotatable sensor, as already explained above.

According to one embodiment, the sensor has a camera. For example, the sensor can have a TOF camera (time-of-flight camera) or be designed as a TOF camera. Alternatively, the sensor can have a laser rangefinder or be designed as a laser rangefinder. Alternatively, the sensor can have an optical scanner or be designed as an optical scanner. Such an optical scanner has at least one light-sensitive sensor that is movably arranged so that the elevator shaft can be scanned by means of the light-sensitive sensor. The optical scanner can optionally have two or more light-sensitive sensors, in particular a camera. Alternatively, the sensor can be, for example, an ultrasonic sensor. Furthermore, the self-climbing lift can have several sensors that allow for different measuring principles, for example one or more cameras and/or one or more ultrasonic sensors. In the case of several sensors, these can be arranged on the same platform or on different platforms of the self-climbing lift.

It should be understood that in this description some features, advantages and/or
embodiments are described only with reference to one of the aforementioned aspects,
but that these features, advantages and/or embodiments can readily be transferred to
one of the other aspects, wherein a repeated description of these features, advantages
and/or embodiments has been omitted in order to provide a concise description and not
to obscure the inventive idea on which the invention is based.

Embodiments of the invention will be described below with reference to the
accompanying drawing, wherein neither the drawing nor the description are intended to
be interpreted as limiting the invention.

Fig. 1 shows a concomitantly rising self-climbing lift with an elevator shaft according
to an embodiment of the invention.

Fig. 2 shows a flow chart for a method for measuring the elevator shaft according to an
embodiment of the invention.

The drawings are merely schematic and are not to scale. In the different figures,
identical reference signs denote identical or similar features.

Fig. 1 shows a concomitantly rising self-climbing lift 1 with an elevator shaft 2
according to an embodiment of the invention. The self-climbing lift 1 can also be
referred to as a concomitantly rising elevator system. The elevator shaft 2 is located
inside a building 3. The building 3 is still under construction, wherein it is possible that
the elevator shaft 3 is not yet completed. For example, the elevator shaft 3 may not yet
have a ceiling and is therefore open at the top. Through the corresponding opening, the
self-climbing lift 1 can be lifted into the elevator shaft 3 by means of a crane (not
shown) and, if necessary, relocated vertically within the elevator shaft 3.

The self-climbing lift 1 can be used in particular to transport persons and/or loads in the
elevator shaft 2 from one floor of the building 3 to another floor of the building 3. A
corresponding shaft opening 5 can be formed in each of the floors through which the elevator
shaft 2 can be entered or exited. Accordingly, each shaft opening 5 of the elevator shaft is

assigned to a floor of building 3. Furthermore, assembly work can be carried out in the elevator shaft 2 by means of the self-climbing lift 1, for example automatically, which is explained in more detail below. As the height of building 3 increases, the self-climbing lift 1 can then be positioned progressively ever higher within the elevator shaft 2 until the building 3 and, in particular, the elevator shaft 2 are completed. The self-climbing lift can then be replaced with a “normal” elevator. For example, the elevator shaft 2 extends in a vertically direction through the building 3. The elevator shaft 2 is bounded laterally by several shaft walls 4.

The self-climbing lift 1 has a protective platform 12, a machine platform 10, at least one first support means 14 and optionally an installation platform 16. The mentioned platforms are removed from the elevator shaft 2 when the self-climbing lift is replaced with a “normal” elevator so that they are only temporarily arranged in the elevator shaft 2. The protective platform 12 is arranged in the elevator shaft 2. The first support means 14 is mechanically coupled to the protective platform 12. The machine platform 10 is arranged in the elevator shaft 2 below the protective platform 12 and mechanically coupled to the first support means 14 in such a way that the machine platform 10 can be relocated vertically in the elevator shaft 2 by means of the first support means 14.

The installation platform 16 is suspended so as to be vertically relocated in the elevator shaft 2 in a vertical direction between the protective platform 12 and the machine platform 10. The installation platform 16 can, for example, have a frame 25, on the top of which a suspension, for example a hook 29, can be fastened. The installation platform 16 can, for example, be suspended from the protective platform 12 by means of the first support means 14, for example on the hook 29. For example, the first support means 14 can be coupled on the one hand to the installation platform 16 and on the other hand to the machine platform 10. Alternatively, the installation platform 16 can be suspended from the protective platform 12 by means of a second support means 15. The second support means 15 can be a section of the first support means 14, wherein the first support means 14 is arranged on one side of a deflection pulley 18, and the second support means 15 is arranged on the other side of the deflection pulley 18. Alternatively, the second support means 15 can be a support means independent of the first support means 14 (not shown). The latter makes it possible to suspend the mechatronic

installation platform 16 on the protective platform 12 (not shown) independently of the machine platform 10.

5 The installation platform 16 can be used by a technician or construction worker to attach the elevator components to the shaft walls 4. Alternatively or additionally, the installation platform 16 can have a mechatronic installation device (not shown) that is designed for the automatic installation of at least one of the elevator components in the elevator shaft 2. The mechatronic installation device can be designed as an industrial robot and have an adjustable robot arm. The industrial robot can be designed so that elevator components can be mounted
10 within the elevator shaft 2, in particular on the shaft walls 4 of the elevator shaft 2, by means of the industrial robot. For this purpose, in particular to be able to find its way around and orient itself in elevator shaft 2 and to find the correct positions of or for the components, the industrial robot can use a digital model of the elevator shaft 2. The elevator components can, for example, have fasteners, clamps, brackets 6 and/or one or more guide rails 7.

15 The self-climbing lift 1 can additionally have, for example, an elevator car 28, a counterweight 22, a first relocation device 34, for example in the form of a winch, optionally a second relocation device and a drive machine 36. The elevator car 28 can be used to carry one or more persons and/or loads during the normal mode of the self-climbing lift 1. The elevator car 28 can, for example, be suspended on the machine
20 platform 10 vertically relocatable below the machine platform 10, for example by means of a third support means 30 which is mechanically coupled to the machine platform 10. The elevator car 28 can be mechanically coupled to the guide rail 7 in such a way that the guide rail guides the elevator car 28 during its vertical relocation. The guide rail 7 can be
25 fastened to one of the shaft walls 4 by means of the brackets 6. The counterweight 22 can be arranged in the elevator shaft 2 and serve to vertically relocate and/or hold the elevator car 28. The counterweight 22 can, for example, be mechanically coupled to the elevator car 28 via the third support means 30. For example, the third support means 30 can run from the counterweight 22 via one or more additional deflection pulleys 18 that are
30 arranged on the machine platform 10 to the elevator car 28.

The first relocation device 34 can, for example, be mechanically coupled to the first support means 14 and serve to relocate the first support means 14, which allows the machine platform 10 and/or the installation platform 16 to be relocated vertically. If the installation

platform 16 can be relocated vertically independently of the machine platform 10 by means of the second support means 15, then the second support means 15 can optionally be relocated by means of the second relocation device (not shown) in order to relocate the installation platform 16 vertically. The drive machine 36 can, for example, be mechanically coupled to the third support means 30 and serve to relocate the third support means 30, which allows the elevator car 28 to be relocated vertically. For example, the drive machine 36 can be mechanically coupled to the third support means 30 via a drive pulley 38. In contrast, the first support means 14 can be wound more or less on an extension of a motor shaft of the first relocation device 34, depending on the vertical position of the installation platform 16. The aforementioned relocation devices and the drive machine are arranged in particular on the machine platform 10. However, it is also possible that at least one of the aforementioned components, for example the first relocation device, is arranged on the protective platform.

The self-climbing lift 1 can assume different operating states. For example, in a first operating state, the protective platform 12 and the machine platform 10 can be permanently arranged in their vertical positions in the elevator shaft 2, in other words secured, fixed or fastened, so that they cannot be relocated vertically in the first operating state. For example, the protective platform 12 and/or the machine platform 10 can each have two or more support elements 42 by means of which the protective platform 12 or the machine platform 10 can be firmly coupled to the elevator shaft 2. For example, the support elements 42 can extend in the side of the protective platform 12 or the machine platform 10, i.e., laterally from the protective platform 12 or the machine platform 10 and be placed on supports 40 formed in the shaft walls 4. In the first operating state, the elevator car 28 can be relocated vertically below the machine platform 10, for example to transport persons and/or loads. Furthermore, in the first operating state, the installation platform 16 can be relocated vertically so that assembly work in the elevator shaft 2 can be carried out from the installation platform 16 at different height levels vertically between the machine platform 10 and the protective platform 12, automatically in the case of the industrial robot. The first operating state represents the “normal” mode of the self-climbing lift 1.

In a second operating state of the self-climbing lift 1, the protective platform 12 can be permanently arranged in its vertical position in the elevator shaft 2, and the machine platform 10 can be relocated vertically, for example by means of the first support means 14 and the first relocation device 34. This makes it possible to vary the vertical

region to which persons and/or loads can be transported by means of the elevator car 28 depending on the construction progress of building 3.

5 In a third operating state, the protective platform 12 can be relocated vertically. For this purpose, the protective platform 12 can be mechanically coupled to the crane (not shown) which is arranged externally with respect to the self-climbing lift 1, and can be relocated vertically within the elevator shaft 2 by means of the crane. This makes it possible, depending on the progress of constructing the building 3 in the elevator shaft 2, to vary on the one hand both the vertical region to which persons and/or loads
10 can be transported by means of the elevator car 28, and on the other hand the vertical region in which the assembly work is carried out. The third operating state represents a self-climbing mode of the self-climbing lift 1.

15 The self-climbing lift 1 has a first platform which is relocatably arranged in the elevator shaft 2, for example the protective platform 12. The self-climbing lift 1 has at least one second platform which is mechanically coupled to the first platform by means of the first support means 14 and which is relocatably arranged in the elevator shaft 2 below the first platform 14, for example the machine platform 10 or the installation platform 16. At least one sensor 44 is arranged on at least one of the platforms, for example on the protective
20 platform 12, the machine platform 10 or on the installation platform 16. The sensor 44 can be arranged on, under or to the side of the corresponding platform. Optionally, two or more of the sensors 44 can be arranged on the corresponding platform. Furthermore, one, two or more of the sensors 44 can be arranged on two or all three platforms.

25 Each of the sensors 44 is designed in such a way that a measured value can be detected by means of the sensor 44 while the corresponding platform is being relocated. The measured value is representative of a property of elevator shaft 2. This could mean, for example, that conclusions about the property can be drawn from the measured value. In addition to the single measured value, a number of additional measured values can be
30 detected, in particular while the corresponding platform is being relocated. The additional measured values can refer to the same property of elevator shaft 2. Alternatively or additionally, two or more first measured values can refer to a first property of the elevator shaft 2, and one, two or more second measured values can refer to a second property of the elevator shaft 2. Accordingly, during the relocation of the corresponding platform,

two or more properties of the elevator shaft 2 can be determined by means of recording corresponding first and second or corresponding additional measured values.

5 The property of the elevator shaft 2 to be recorded can be, for example, the height, width, depth or length of elevator shaft 2. The measured value that is representative of the property can therefore be, for example, the height, width, depth or length of the elevator shaft 2. The property to be recorded for elevator shaft 2 can also be the position of a single point or the positions of several points on a shaft wall of elevator shaft 2. The property to be recorded can also refer to the positions and/or sizes of one or
10 more of the elevator components that are permanently arranged in the elevator shaft 2. Accordingly, within the meaning of this description, not only the shaft walls 4 of the elevator shaft 2 are assigned thereto, but also the elevator components that are permanently installed in the elevator shaft 2. These elevator components can, for example, have or be clamps, brackets, supports 6, angles and/or the guide rail 7.

15 Each of the sensors 44 can have a detection region 46 within which the measured value can be detected. The corresponding sensor 44 can in particular be arranged on the corresponding platform in such a way that its detection region 46 is directed outwards with respect to the corresponding platform. The fact that the detection region 46 is
20 directed outwards with respect to the corresponding platform can mean that the detection region 46 is directed towards one of the shaft walls 44 of the elevator shaft 2. The detection region 46 can also be referred to as the operational detection region. If the sensor 44 is an optical sensor, for example a camera, then the detection region 46 can be, for example, the field of view or the angle of view of the camera.

25 The sensor 44 can be arranged in such a way that it is movable and that the detection region 46 can be changed accordingly. For example, a scanning movement can be performed by means of the sensor 44, which allows a region of the elevator shaft 2 to be scanned by means of the sensor 44 that is larger than the detection region 46. A scan direction in which
30 the sensor 44 can be moved can be at least partially horizontally oriented so that the elevator shaft 2 can be scanned in a horizontal direction by means of the scanning movement and in the vertical direction by means of relocating the corresponding platform. For example, when determining the property and/or when correspondingly recording the measured value, the sensor 44 can be rotated, for example by 360°, for example by a vertical axis of rotation 48, so

that a horizontal region around the sensor 44 can be scanned by means of the sensor 44. In other words, the scanning movement can be a rotational movement. Alternatively, the scanning movement can have a vertical component in addition to the horizontal component. For example, the scanning movement can be meandering.

5

The self-climbing lift 44 can have two or more of the sensors 44. These additional sensors 44 can be arranged on the same platform as the one sensor 44. The additional sensors 44 can be oriented in such a way that an additional detection region 46 of the additional sensors 44 is a different region than the detection region 46 of the one sensor 44.

10

For example, an additional detection region 46 of one of the additional sensors 44 can be directed in a different direction than the detection region 46 of the one sensor 44.

Optionally, three or more additional sensors 44, for example four, can be arranged on the corresponding platform whose additional detection regions 46 differ at least partially from each other. For example, the additional sensors 44 can be arranged so that their detection regions 46 overlap each other in a horizontal direction so that the elevator shaft 2 can be scanned all around by means of the sensors 44. In the case of four sensors 44, their additional detection regions 46 can each be directed towards one of the shaft walls 4 of the elevator shaft 2 so that all four shaft walls 4 can be scanned simultaneously by means of the sensors 44. As an alternative to these several additional sensors 44, a single sensor 44 can be rotatably arranged on the corresponding platform so that the elevator shaft 2 can be scanned all around by means of the one rotatable sensor 44, as already explained above.

15

20

The sensor 44 can have or be a camera. For example, the sensor 44 can have a TOF camera or be designed as a TOF camera. Alternatively, the sensor can have a laser rangefinder or be designed as a laser rangefinder. Alternatively, the sensor 44 can have an optical scanner or be designed as an optical scanner. Such an optical scanner has at least one light-sensitive sensor that is movably arranged so that the elevator shaft 2 can be scanned by means of the light-sensitive sensor. The optical scanner can optionally have two or more light-sensitive sensors, in particular a camera. Alternatively, sensor 44 can be, for example, an ultrasonic sensor.

25

30

Furthermore, the self-climbing lift 1 can have several of these sensors 44 that allow for different measuring principles, for example one or more cameras and/or one or more ultrasonic sensors. In the case of several sensors 44, these can be arranged on the same platform or on different platforms of the self-climbing lift 1.

The self-climbing lift 1 can have a control unit 20. The control unit 20 is communicatively coupled to the sensor 44. The control unit 20 has a storage unit 22 and a processor 24. The storage unit 20 serves to store the at least one measured value that is representative of the property of the elevator shaft 2. The processor 24 is designed to execute the method described above and below.

Fig. 2 shows a flow chart for a method for measuring the elevator shaft 2 according to an embodiment of the invention. The method serves to measure the elevator shaft 2 already during its construction. The method can be executed entirely or partially by the control unit 20 of the self-climbing lift 1.

In an optional step S2, the control unit 20 can send a relocation signal to the unit that is responsible for moving the platform having the sensor 44. For example, if the platform having the sensor 44 is the protective platform 12, it can be relocated by means of the crane external with regard to the self-climbing lift 1, and the relocation signal can be sent to a crane controller of the crane. For example, if the platform having the sensor 44 is the machine platform 10 or the installation platform 16, the control unit 20 can send the relocation signal to the first relocation device 34 of the self-climbing lift 1, which is responsible for relocating the machine platform 10 or the installation platform 16.

In step S4, a detection signal can be sent to the sensor 44 which is fastened to the corresponding platform to be relocated, wherein the sensor 44 is designed to detect at least one of the measured values that is representative of the property of the elevator shaft 2 in response to receiving the detection signal while the corresponding platform is being relocated. The sensor 44 is further designed to generate a measuring signal as a result of the detection of the measured value, which measuring signal is representative of the measured value and accordingly of the property of the elevator shaft 2. If the sensor 44 records multiple measured values and/or a trend of the measured values, the measured values or the trend of the measured values can be encoded in the measuring signal. In this case, the measuring signal is representative of the measured values or the trend of the measured values.

The measured value can be detected by means of one of the sensors 44 that are fastened to the corresponding platform. In particular, the platform having the sensor can be relocated during the self-climbing mode of the self-climbing lift 1 and the measured

value can be detected during the self-climbing mode. Optionally, the elevator shaft 2 can already be measured and, in particular, the measured value can be detected when the self-climbing lift 1 and, in particular, the platform having the sensor 44, are lowered into the elevator shaft 2 from above for the first time by means of the external crane.

5 Preferably, the measured value is detected several times during the relocation of the platform, for example continuously, wherein a measured signal that is detected by the sensor can then be representative of a course of the measured value.

10 In step S6, the measuring signal can be received that is representative of the property of the elevator shaft 2. The measuring signal and/or, in particular, the measured values can be stored on the storage unit 22 for further processing.

15 In step S8, a digital model of the elevator shaft 2 can be created depending on the detected measured value, for example by means of the control unit 20. The detected measured values can together form the digital model of elevator shaft 2. The digital model can therefore comprise a digital data set in which several of the additional measured values are encoded in addition to the one measured value. The digital model of elevator shaft 2 can be representative of the fully measured elevator shaft 2. The digital model of elevator shaft 2 can also be stored on storage unit 22. It is also possible for the digital model to be created
20 from the measuring signals in a subsequent step, independently of the control unit 20.

Finally, it should be noted that terms such as “having,” “comprising,” etc., do not exclude other elements or steps, and terms such as “a” or “an” do not exclude a plurality. Furthermore, it should be noted that features or steps which have been
25 described with reference to one of the above exemplary embodiments may also be used in combination with other features or steps of other exemplary embodiments described above. Reference signs in the claims should not be considered to be limiting.

Claims

1. A method for measuring an elevator shaft (2) by means of a concomitantly rising self-climbing lift (1) for transporting a load from one floor to another floor within a building (3) under construction, wherein the self-climbing lift (1) has a platform that is temporarily arranged in the elevator shaft (2), characterized in that the method comprises the following method steps:
sending a detection signal to a sensor (44) which is fastened to the platform, wherein the sensor (44) is designed to detect at least one measured value that is representative of a property of the elevator shaft (2) in response to receiving the detection signal while the platform is being relocated;
receiving a measuring signal from the sensor (44) that is representative of the measured value; and
creating a digital model of the elevator shaft (2) depending on the detected measured value.
2. The method according to claim 1, wherein
the platform is relocated during a self-climbing mode of the self-climbing lift (1),
the detection signal is sent to the sensor (44) during self-climbing mode, and
the sensor (44) is designed to record the measured value during self-climbing mode.
3. A control unit (20) for a concomitantly rising self-climbing lift (1) for erecting the self-climbing lift (1) having an elevator shaft (2) for transporting a load from one floor to another floor within a building (3) under construction, wherein the self-climbing lift (1) comprises:
a first platform which is relocatably arranged in the elevator shaft (2);
a second platform which is mechanically coupled to the first platform by means of a first support means (14) and which is relocatably arranged in the elevator shaft (2) below the first platform;
at least one sensor (44) which is arranged on one of the platforms and which is arranged and designed in such a way that a measured value can be detected by means of the sensor (44), which measured value is representative of a property of the elevator shaft (2) while the corresponding platform is being relocated;
the control unit (20) having:

a storage unit (22) for storing at least one measured value that is representative of a property of the elevator shaft (2); and
a processor (24) that is designed to execute the method according to any of claims 1 or 2.

5 4. A self-climbing lift (1) in the form of a concomitantly rising self-climbing lift (1) that has an elevator shaft (2) for transporting a load from one floor to another floor within a building (3) under construction, the self-climbing lift (1) comprising:
a first platform which is relocatably arranged in the elevator shaft (2);
a second platform which is mechanically coupled to the first platform by means of a
10 first support means (14) and which is relocatably arranged in the elevator shaft (2) below the first platform;
at least one sensor (44) which is arranged on one of the platforms and which is arranged and designed in such a way that a measured value can be detected by means of the sensor (44), which measured value is representative of a property of the elevator
15 shaft (2) while the corresponding platform is being relocated; and
a control unit (20) according to claim 3, which is communicatively coupled to the sensor (44).

 5. The self-climbing lift (1) according to claim 4, comprising:
a protective platform (12) that forms the first platform; and
20 a machine platform (10) which forms the second platform and which is mechanically coupled to the first support means (14) in such a way that the machine platform (10) can be relocated vertically in the elevator shaft (2) by means of the first support means (14).

 6. The self-climbing lift (1) according to claim 5, wherein
25 the sensor (44) is arranged on the protective platform (12).

 7. The self-climbing lift (1) according to claim 5, wherein
the sensor (44) is arranged on the machine platform (10).

30 8. The self-climbing lift (1) according to claim 4, comprising:
a protective platform (12) which forms the first platform;
a machine platform (10) which is arranged in the elevator shaft (2) below the protective platform (12) and which is mechanically coupled to the first support means (14) in such

a way that the machine platform (10) can be relocated vertically in the elevator shaft (2) by means of the first support means (14); and
an installation platform (16) which forms the second platform and which is suspended so as to be vertically relocatable on the protective platform (12) between the protective
5 platform (12) and the machine platform (10) in the elevator shaft (2), wherein the sensor (44) is arranged on the installation platform (16).

9. The self-climbing lift (1) according to any of claims 4 to 8, wherein
the sensor (44) has a detection region (46) within which the measured value can be
10 detected, and the sensor (44) is arranged on the corresponding platform in such a way that the detection region (46) is directed outwards with respect to the corresponding platform.

10. The self-climbing lift (1) according to claim 9, wherein
the sensor (44) is arranged in such a way that it is movable and that the detection
15 region (46) can be changed accordingly.

11. The self-climbing lift (1) according to either claim 9 or claim 10, comprising
at least one additional sensor (44) which is arranged on the same platform as the sensor (44)
and which is oriented in such a way that an additional detection region (46) of the additional
20 sensor (44) is a different region than the detection region (46) of the sensor (44).

12. The self-climbing lift (1) according to any of claims 4 to 11, wherein
the sensor (44) has a camera.