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(71) Applicant: **INVENTIO AG**
6052 Hergiswil (CH)

(72) Inventors:
- **Mielle, Malcolm**
  1020 Renens (CH)
- **Hassan, Mariam**
  1020 Renens (CH)

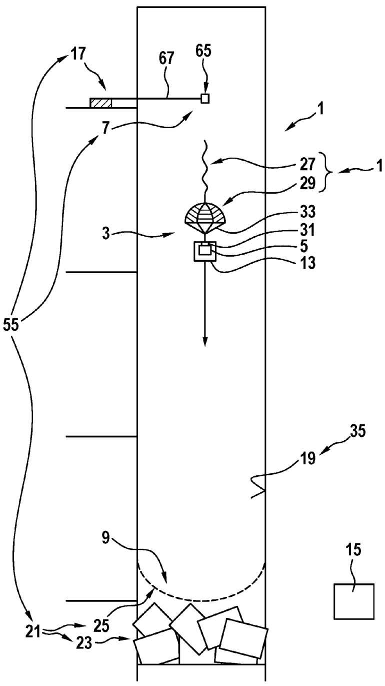
(74) Representative: **Inventio AG**
Seestrasse 55
6052 Hergiswil (CH)

(54) METHOD AND DEVICE FOR MEASURING A SHAFT SUCH AS AN ELEVATOR SHAFT

(57) The invention relates to a method and a measuring arrangement (3) for measuring a shaft, particularly an elevator shaft, the method comprising:
providing the measuring arrangement comprising a measuring device (5) configured for measuring dimension data relating to objects (35) in an environment surrounding the measuring device,
arranging the measuring arrangement at an upper level (7) within the shaft,
releasing the measuring arrangement such that the measuring arrangement drops in a falling motion along the shaft,
acquiring dimension data of the shaft using the measuring arrangement during the falling motion, and
catching the measuring arrangement after the falling motion at a lower level (9) within the shaft.

The measuring arrangement comprises a housing (13), the measuring device accommodated within the housing, and an aerodynamics device (11) mechanically coupled to the housing. The aerodynamics device is configured and coupled to the housing such as to stabilize an orientation of the housing upon the measuring arrangement dropping in the falling motion along the shaft.

Fig. 1



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Description

[0001] The present invention relates to a measuring method and a measuring device with the aid of which a shaft, such as an elevator shaft, may be measured and/or mapped.

[0002] Embodiments of the invention are described herein mainly with reference to measuring dimensions of an elevator shaft. However, the ideas and embodiments described herein may also be applied to measuring dimensions of any other type of shaft. Therein, a shaft is generally referred to as an elongate volume which is enclosed by surrounding walls, such walls preferably extending in a vertical direction.

[0003] An elevator installation generally has an elevator shaft within which an elevator car, and possibly a counterweight, may be vertically displaced.

[0004] When constructing a building or installing an elevator system in a building, it must regularly be ensured that the elevator shaft complies with geometric and/or structural specifications within predefined tolerance ranges. For example, it should be verified that walls of the elevator shaft are vertical within acceptable tolerances, that a cross-section of the elevator shaft remains the same along a height extension of the elevator shaft within acceptable tolerances, etc.

[0005] Accordingly, it may be necessary to precisely measure the elevator shaft during construction of the building or before or during installation of the elevator system.

[0006] Approaches have been developed to at least partially automate the measurement of an elevator shaft.

[0007] For example, JP 2005 098786 A describes a device for measuring dimensions of an elevator shaft in which a laser distance measuring device for measuring a distance in a horizontal plane is attached to an elevator car and can be moved vertically through the elevator shaft with the elevator car to measure lateral distances at different height positions. However, such approach requires that the elevator system is already fully installed. Before the elevator installation is completed, neither the elevator car nor a drive exists to move it through the elevator shaft.

[0008] WO 2009/073010 A1 describes methods and devices for monitoring elevator shafts. A platform can be moved along the elevator shaft by means of a drive machine to be mounted in the elevator shaft beforehand, and a distance sensor can be used to measure a lateral distance between a point on the platform and a wall of the elevator shaft. However, installation of such a device in an elevator shaft may be relatively costly and/or measurement results concerning dimensions of the elevator shaft may not be sufficiently precise in some cases.

[0009] WO 2020/178224 A1 describes a measuring device for measuring an elevator shaft and use of the measuring device to measure an elevator shaft. The measuring device has two rope-like, elongated and parallel guide elements, a measuring platform and a lifting device. Each of the guide elements is fixed at an upper holding point and at a lower holding point in the elevator shaft and braced between the upper holding point and the lower holding point. The measuring platform has guide devices which support the measuring platform laterally on the guide elements and guide the measuring platform in a displacement movement in a displacement direction parallel to the guide elements. The measuring platform has a distance measuring device to measure lateral distances to side walls of the elevator shaft. The lifting device is configured to move the measuring platform in the displacement direction.

[0010] However, conventional approaches for measuring an elevator shaft generally require substantial efforts and/or costs for providing complex measurement equipment and/or installing such equipment within the shaft.

[0011] There may be a need for, among other things, an alternative shaft measuring approach that may be easily used in a shaft such as an elevator shaft and/or by means of which the shaft may be reliably and accurately measured. Particularly, there may be a need for a shaft measuring approach which requires no or little installation efforts and/or which may be implemented using relatively simple measurement equipment.

[0012] Such need may be met with the subject-matter of one of the independent claims. Advantageous embodiments are defined in the dependent claims as well as in the following specification and the accompanying figures.

[0013] According to a first aspect of the present invention, a method for measuring a shaft, particularly an elevator shaft, is proposed. The method comprises at least the following steps, preferably in the indicated order:

providing a measuring arrangement comprising a measuring device configured for measuring dimension data relating to objects in an environment surrounding the measuring device,

arranging the measuring arrangement at an upper level within the shaft,

releasing the measuring arrangement such that the measuring arrangement drops in a falling motion along the shaft,

acquiring dimension data of the shaft using the measuring arrangement during the falling motion, and

catching the measuring arrangement after the falling motion at a lower level within the shaft.

[0014] According to a second aspect of the invention, a measuring arrangement for measuring a shaft, particularly an elevator shaft, is proposed. The measuring arrangement comprises at least a housing, a measuring device being accommodated within the housing and an aerodynamics device being mechanically coupled to the housing. Therein, the measuring device is configured for measuring dimension data relating to objects in an environment surrounding the measuring device. Furthermore, the aerodynamics device is configured and coupled to the housing such as to stabilize an orientation of the housing upon the measuring arrangement dropping in a falling motion along the shaft.

[0015] According to a third aspect of the invention, a measuring kit for measuring a shaft, particularly an elevator shaft, is proposed. The measuring kit comprises the measuring arrangement according to an embodiment of the second aspect of the invention and further comprises a holding arrangement and/or a catching arrangement. The holding arrangement is configured to be fixed at the upper level and holding the measuring arrangement at a starting position distant from each of multiple walls of the shaft and releasing the measuring arrangement by disengaging the measuring arrangement from the holding arrangement. The catching arrangement includes at least one of a cushion configured for being arranged within the shaft at a position below the lower level and a net configured for spanning the shaft at a position below the lower level.

[0016] Briefly summarised and without limiting the scope of the invention, basic ideas underlying embodiments of the invention and associated possible advantages will be roughly described as follows:

As indicated above, conventional approaches for measuring a shaft generally require substantial efforts and complex machinery for, on the one hand, providing a measuring device for measuring dimensions of the shaft and for, on the other hand, providing a displacing device which may suitably displace such measuring device along the vertical extension of the shaft. The approach described herein is substantially simplified based on the finding that a measuring device may simply travel along the vertical extension of the shaft in a falling motion while at the same time acquiring dimension data of the shaft. It has been found that, in such falling motion, the dimension data may be acquired with sufficient accuracy, particularly in cases where the measuring device is part of a measuring arrangement in which an additional aerodynamics device serves for stabilising an orientation of a housing accommodating the measuring device during the falling motion.

[0017] In the following, possible features of embodiments of the invention and associated possible advantages will be described in more detail.

[0018] Embodiments of the method and device proposed herein enable measuring a shaft, particularly an elevator shaft. Particularly, it shall be possible to measure an elevator shaft under construction or already completed, in which an elevator system has not necessarily yet been installed. For example, it should be possible to determine whether lateral walls of the elevator shaft are aligned vertically in a desired precise manner and run parallel to each other or whether, for example, due to defects or inaccuracies during construction, excessive deviations from a given geometry have occurred, for example deviations beyond a tolerance of, for example, +/- 25mm. Such deviations may require costly corrective measures. On the one hand, the measurement of the elevator shaft should be carried out with as little effort as possible and allow a high degree of automation. On the other hand, it should be possible to obtain measurement results with a high degree of reliability and precision.

[0019] Therein, the term "measuring a shaft" shall relate to measuring, mapping or determining geometrical characteristics of the shaft and shall include acquiring dimension data representing such geometrical characteristics. Therein, the dimension data may represent for example dimensions of a cross-section of the shaft, i.e. a width and/or a length of the shaft. The dimension data may be acquired at various positions along a height of the shaft. Accordingly, the dimension data may represent a profile of the width and/or length of the shaft, the profile being taken along a vertical direction along at least a portion of the height of the shaft.

[0020] In order to enable measuring the geometrical characteristics of the shaft, the measuring device is configured for measuring dimension data relating to objects in an environment surrounding the measuring device. For example, the measuring device may measure distances of such surrounding objects from the measuring device itself or relative to another surrounding object. Therein, the measuring device may be adapted for measuring the distances within a non-vertical plane, preferably within a horizontal plane. Upon being positioned within a shaft, the surrounding objects are generally the sidewalls of the shaft and/or any components attached to or protruding from such sidewalls. As described in further detail below, various techniques for measuring the dimension data may be applied.

[0021] In accordance with the measuring method proposed herein, the measuring device shall be arranged at an upper level within the shaft from which it may then be released in order to drop in a falling motion along the shaft. During such falling motion, the measuring arrangement may then acquire the dimension data. At the end of the falling motion, the measuring device is catched at a lower level within the shaft.

[0022] As the measuring device shall be submitted to the falling motion and shall be catched after such falling motion, it is accommodated within a housing protecting the measuring device. Such housing may enclose the measuring device. Furthermore, the measuring device may be comprised within the housing in a damped manner such that e.g. decelerating forces induced during the catching process are damped such as to protect the measuring device.

[0023] Furthermore, as the measuring device is subjected to a substantially free fall during the falling motion and, particularly, may not be submitted to and/or guided by other forces than gravitational forces, the measuring device together with the housing may tend to coast freely or spin during the falling motion. As such freely coasting or spinning would result in de-orienting the measuring device and thereby rendering any measuring of dimension data difficult or even impossible, the housing together with the measuring device is coupled to an aerodynamics device. Such aerodynamics device is configured and coupled to the housing in a manner such as to stabilise the orientation of the housing during the falling motion.

[0024] The combination of components including the housing, the measuring device and the aerodynamics device forms the measuring arrangement according to the second aspect of the invention.

[0025] Particularly, according to an embodiment of the measuring method, the aerodynamics device is coupled to the housing accommodating the measuring device of the measuring arrangement and an orientation of the housing is stabilized due to aerodynamic interaction of the aerodynamics device with surrounding air during the falling motion along the shaft.

[0026] In other words, the aerodynamics device is adapted for interacting with quickly moving air flowing along the aerodynamics device during the falling motion in a manner such as to generate forces acting onto the housing such as to substantially prevent the housing from freely coasting or spinning during the falling motion.

[0027] For such purpose, the aerodynamics device may be adapted for, on the one hand, generating a decelerating force, i.e. a drag force, for decelerating the falling motion of the housing. Additionally, the aerodynamics device may be adapted for, on the other hand, generating a guiding force, i.e. a force preventing lateral displacement of the housing during its falling motion. While the decelerating force is directed generally vertically, the guiding force is directed generally non-vertically, i.e. preferably horizontally or at least with a horizontal force component.

[0028] Furthermore, the aerodynamics device may be coupled to the housing in a manner such as to transmit such decelerating force and/or guiding force onto the housing of the measuring arrangement during the falling motion. Accordingly, due to such transmitted forces, the housing with the measuring device comprised therein is, on the one hand, stabilised with regards to its orientation such that the measuring device may acquire the dimension data preferably in a stable horizontal orientation. Furthermore, due to such transmitted forces, the housing is, on the other hand, guided along a substantially vertical path during the falling motion and any substantial lateral deviations from such vertical path may be avoided. Thereby, the measuring arrangement may, inter-alia, be prevented from coming into contact with one of the sidewalls of the shaft during the following motion.

[0029] According to an embodiment, the aerodynamics device may comprise a streamer.

[0030] Such streamer may comprise a flexible sheet-like material such as a textile or textile-like material and thereby form a component. Accordingly, the streamer may flutter in an air flow and may, due to such fluttering, generate decelerating forces and/or guiding forces during the falling motion. In other words, the streamer may behave like a flag upon air flowing along the streamer during the falling motion. Generally, the streamer may be a very simple component, wherein for example a length of the streamer, a width of the streamer and/or material characteristics of the streamer may be adapted such as to enable the streamer to generate the drag forces and/or flutter forces required for stabilising the orientation of the housing and guiding the housing along the vertical path during the falling motion. Generally, the streamer has an elongate shape, such as for example a rectangular shape, with a length of the streamer being longer than its width. For example, the length may be in a range of between 0.3 m and 10 m, preferably between 1 m and 3 m, while the width may be in a range of between 0.1 m and 1 m, preferably between 0.2 m and 0.5 m.

[0031] Additionally or alternatively, according to an embodiment, the aerodynamics device may comprise a pilot chute.

[0032] Such pilot chute may be a small parachute. The pilot chute may be made with a flexible sheet-like material such as a textile or textile-like material. The pilot chute may be deployed from a collapsed configuration to an opened configuration. Contrary to the streamer which, during a falling motion, mainly extends in a direction parallel to the falling direction, the pilot chute's textile material mainly extends in a direction crossing such falling direction. Accordingly, the pilot chute is adapted for generating a dynamic pressure upon being moved through the air during the falling motion. Such dynamic pressure generally is substantially larger than the drag generated by a streamer. Accordingly, the pilot chute may generate stronger decelerating forces than the streamer. The pilot chute generally has lateral dimensions smaller than the lateral dimensions of the shaft i.e. the cross section of the pilot chute is smaller than the cross section of the shaft. For example, the opened pilot chute may have lateral dimensions of between 0.3 m and 3 m, preferably between 0.5 m and 1 m. The opened pilot chute may have a circular cross section. In such implementation, the lateral dimensions correspond to a diameter of the opened pilot chute.

[0033] In principle, the pilot chute may be adapted for opening directly upon the measuring arrangement being released and starting its falling motion. However, it has been observed that the opened pilot chute may, on the one hand, significantly decelerate the falling motion while, on the other hand, tend to induce lateral forces which may result in the entire measuring arrangement being laterally displaced within the shaft during its decelerated falling motion.

[0034] In order to, inter-alia, limit such lateral displacement and avoid, in a worst-case, any contact of the measuring arrangement with the adjacent sidewalls of the shaft, the measuring arrangement may optionally further comprise an activation mechanism for opening the pilot chute during the falling motion.

[0035] The activation mechanism may for example prevent the pilot chute from deploying at a beginning of the falling motion and may allow opening the pilot chute only at a later stage of the falling motion. For example, the activation mechanism may allow opening the pilot chute shortly before reaching the lower level, thereby strongly decelerating the falling motion shortly before the measuring arrangement being catched. Accordingly, the measuring arrangement may relatively freely fall at a beginning of its falling motion, only being stabilised in its orientation for example due to the action of a streamer, and may then be decelerated by opening the pilot chute shortly before reaching the end of its travel path. Accordingly, quick and/or straight falling motion vertically along the shaft may be enabled while preventing damages to the measuring arrangement upon the measuring arrangement being catched at excessive velocities. For example, the activation mechanism may comprise a timer for timing the opening of the pilot chute. Alternatively or additionally, the activation mechanism may comprise a position determination unit for determining its position along the travel path throughout the shaft such as to enable opening the pilot chute at a predefined position before reaching the lower level.

[0036] According to an embodiment, the aerodynamics device may be coupled to the housing via a string-like connection.

[0037] Such string-like connection may comprise for example one or preferably multiple strings, lines, ropes, cords, chains or similar components interconnecting the housing with the aerodynamics device. Specifically, the string-like connection may be tensioned and transmit forces along its extension direction while being flexible in a lateral direction orthogonal to the extension direction. Due to such string-like connection, decelerating forces and/or guiding forces may be transmitted between the aerodynamics device and the housing while still allowing some tolerance between a position of the housing, on the one side, and a position of the aerodynamics device, on the other side. Due to such tolerance, the measuring arrangement may be easily handled and/or may be submitted to a stable falling motion.

[0038] According to an embodiment, the measuring device is configured for measuring the dimensions relating to objects in the environment surrounding the measuring device in a contactless manner.

[0039] In other words, the measuring device may acquire the dimensions data without requiring any mechanical contact with the surrounding object, i.e. with e.g. the sidewalls in the shaft. Accordingly, any disturbances and/or inaccuracies as well as friction and/or wear resulting from a required mechanical contact may be avoided. For example, such contactless measurements may rely on optical measurements. E.g., a laser distance measuring device may be used to direct a laser beam towards a side wall and a distance between the side wall and the measuring device may be deduced from time-of-flight measurements, phase shift measurements or similar measurements. Alternatively, e.g. ultrasonic sensors may be used to emit ultrasonic signals towards the side wall and to infer the distance to be bridged by time-of-flight measurements or similar.

[0040] According to an embodiment, the measuring device may be configured for measuring distances between the objects in the environment surrounding the measuring device and the measuring device itself.

[0041] Expressed differently, the measuring device may be embodied as a distance measuring device. Accordingly, due to being able to measure a distance between for example a sidewall in the shaft and the position of the measuring device itself, detailed dimension data indicating structural characteristics of such sidewall may be acquired. For example, the measuring device may be able to measure distances in opposite directions, i.e. between itself and opposing side walls of the shaft, thereby enabling measuring a width and/or length of the shaft. Preferably, the measuring device may be able to measure such distances in multiple lateral directions, particularly in two or more lateral directions being orthogonal to each other such as to enable measuring both, the width and the length of for example a rectangular cross-section of the shaft. In other words, the distance measuring device may measure lateral distances not only to one of the walls of the lift shaft, but preferably to several or even all walls of the lift shaft. For this purpose, the distance measuring device can have several measuring components that can measure distances in one of several lateral directions. For example, four measuring components may be provided, each of which may measure a lateral distance towards one of the four walls of the elevator shaft. Measurement directions of the measurement components may be arranged at right angles relative to each other. Alternatively, the distance measuring device may have a measuring component that can be oriented in different measuring directions. For example, the measuring component can be rotated around a vertical axis in order to align it in different lateral directions and then measure lateral distances to opposite side walls.

[0042] For example, according to an embodiment, the measuring device may comprise an optical scanner device, a radar device or a lidar device.

[0043] The optical scanner device may for example emit a light beam in various lateral directions in order to measure distances of surrounding objects such as shaft walls reflecting portions of the light beam. The distances may be measured using e.g. time-of-flight techniques. Similarly, the radar device may emit electromagnetic signals and detect portions thereof upon being reflected at the shaft walls. A lidar device (Laser Imaging, Detection And Ranging) uses a method for determining ranges by targeting an object or a surface with a laser and measuring the time for the reflected light to return to a receiver. It is sometimes called 3-D laser scanning, a special combination of 3-D scanning and laser scanning. All such devices use techniques which allow rapidly measuring distances, thereby enabling acquiring the dimension data at a sufficiently high frequency during the fast falling motion of the measuring arrangement.

[0044] According to a specific implementation, the measuring device may, for example, comprise a laser distance measuring device and may be configured to measure lateral distances by means of a laser beam which is rotationally oriented in a horizontal plane in different directions. Thus, a laser distance measuring device may be used and a laser beam used by the laser distance measuring device for distance measurement may be directed in different lateral directions towards the plurality of shaft walls surrounding the elevator shaft to measure a current lateral distance thereto. In doing so, the entire laser distance measuring device may be rotated in a horizontal plane. Alternatively, a rotating mirror may be used to redirect the laser beam emitted by the laser distance meter in the various lateral directions. The use of a laser distance meter with a rotating laser beam may enable precise, non-contact and reliable measurement of the elevator shaft.

[0045] According to an embodiment, the measuring device comprises at least one of a range sensing unit, an inertial motion sensing unit, a height determination unit, a computing unit and an energy storage unit.

[0046] The range sensing unit may sense ranges, i.e. measure distances, and may be implemented using e.g. a laser scanner or a radar scanner as indicated above.

[0047] The inertial motion sensing unit may sense accelerations acting onto the measuring arrangement and/or its measuring device. The inertial motion sensing unit may sense the accelerations in one, two or three dimensions. Information about the sensed accelerations may be used e.g. upon processing the acquired dimension data.

[0048] The height determination unit may sense an actual height of the measuring arrangement. During the falling motion, such height generally corresponds to a position along the vertical extension within the shaft. Accordingly, such information may be used e.g. upon processing the acquired dimension data. For example, the height determination unit may be configured for determining the actual height based on an air pressure measurement. Alternatively or additionally, other techniques may be implemented in the height determination unit such as using a laser distance measuring device for determining a distance of the measuring arrangement from a pit or a ceiling of the shaft or using position data determined based on information provided by a global positioning system (GPS) or a local positioning system.

[0049] The computing unit may be adapted for processing data such as the dimension data provided by the measuring device, acceleration data provided by the inertial motion sensing unit, height data provided by the height determination unit, etc. The computing unit may comprise a data processor, data memory and/or one or more data interfaces for data communication.

[0050] The energy storing unit may store energy and supply energy to each of the measuring device and other units and/or sensors. For example, the energy storing unit may be a battery.

[0051] According to an embodiment of the proposed method, the dimension data may be stored during the falling motion and read-out after catching the measuring arrangement for subsequent data processing. Alternatively or additionally, the dimension data may be transmitted during the falling motion to a remote data processing device.

[0052] In other words, the measuring device may acquire the dimension data continuously or in short time intervals during the falling motion and then intermediately store such dimension data for example in a data memory comprised in the measuring arrangement. Accordingly, at a later stage after having catched to the measuring arrangement subsequent to the falling motion, the stored dimension data may be read out and may be forwarded to a data processing unit.

[0053] Alternatively or additionally, the dimension data acquired by the measuring device may be transmitted continuously or in short time intervals directly during the falling motion to a remote data processing device. For such purpose, the measuring arrangement may comprise a data transmission unit. Such data transmission unit may for example be adapted for wireless data transmission.

[0054] According to an embodiment of the method proposed herein, the measuring arrangement is arranged at the upper level within the shaft by engaging the measuring arrangement with a holding arrangement positioned and/or fixed at the upper level, the holding arrangement holding the measuring arrangement at a starting position distant from each of multiple walls of the shaft, and the measuring arrangement is then released by disengaging the measuring arrangement from the holding arrangement.

[0055] In other words, the measuring arrangement is preferably not simply manually thrown into the shaft at the upper level as such throwing would generally imply that the measuring arrangement has a not precisely defined starting condition and, particularly, may have a horizontal motion component upon starting the falling motion. Instead, it is suggested to initially hold the measuring arrangement by a specific holding mechanism of a holding arrangement. Particularly, the measuring arrangement shall be held at the starting position being sufficiently spaced from each of the sidewalls of the shaft. Starting with such precisely defined initial conditions, the measuring arrangement may then be released by disengaging it from the holding arrangement, thereby initiating the falling motion in a precisely defined manner.

[0056] For such purpose, the measuring kit according to the third aspect of the invention may comprise the holding arrangement configured to be positioned and/or fixed at the upper level and holding the measuring arrangement at the starting position distant from each of multiple walls of the shaft and releasing the measuring arrangement by disengaging the measuring arrangement from the holding arrangement.

[0057] Furthermore, according to an embodiment of the proposed method, the measuring arrangement is catched after the falling motion using a catching arrangement including at least one of a cushion arranged within the shaft at a position at or below the lower level and a net spanning the shaft at a position at or below the lower level.

[0058] Expressed differently, at the end of the falling motion, the measuring arrangement may be decelerated and thereby catched using a specific catching arrangement. Such catching arrangement may comprise e.g. a cushion. Therein, the term "cushion" may be interpreted broadly to refer to an arrangement configured for cushioning or damping an impact of a falling object. For example, a pit of the shaft may be filled with foam components or with a mattress. Additionally or alternatively, the catching arrangement may comprise a net spanning the shaft such as to catch the falling measuring arrangement at the end of its falling motion. Therein, the term "net" shall again be interpreted broadly to refer to an arrangement configured for spanning at least portions of a cross section of the shaft and being able to non-abruptly decelerate the falling motion of the measuring arrangement upon impacting onto the net.

[0059] For such purpose, the measuring kit according to the third aspect of the invention may comprise the catching arrangement including at least one of a cushion configured for being arranged within the shaft at a position below the lower level and the net configured for spanning the shaft at a position below the lower level.

[0060] According to an embodiment, the housing is provided with a dampening arrangement configured for damping forces upon the measuring arrangement being catched at an end of the falling motion.

[0061] Due to such dampening arrangement, the measuring device may be prevented from being submitted to excessive forces upon the measuring arrangement being catched. In other words, impact forces occurring with such catching action may be cushioned by the damping arrangement in order to thereby protect the potentially shock-sensitive measuring device. For example, some dampening provisions may be implemented at an outer side of the housing and/or between the housing and the measuring device accommodated therein.

[0062] It is to be noted that some embodiments of the invention are described herein with respect to a method for measuring a shaft while other embodiments are described with respect to a measuring arrangement or a measuring kit configured for implementing such method. One skilled in the art readily recognizes that features may suitably be transferred between these various embodiments, and features may be modified, adapted, combined and/or replaced, etc. to arrive at still further embodiments of the invention.

[0063] In the following, advantageous embodiments of the invention are described with reference to the enclosed drawings. However, neither the drawings nor the description shall be interpreted as limiting the invention.

Fig. 1 shows an elevator shaft with a measuring arrangement for measuring the shaft in accordance with an embodiment of the present invention.

Fig. 2 shows a measuring device of a measuring arrangement in accordance with an embodiment of the present invention.

[0064] The figures are only schematic and not to scale. Same reference signs refer to same or similar features.

[0065] Fig. 1 schematically illustrates an embodiment of a shaft 1 such as an elevator shaft upon being measured using a measuring arrangement 3. Such measuring serves, inter-alia, for mapping a geometry of the shaft 1, i.e. providing detailed information about walls 19 defining a cross-section of the shaft 1 along a vertical extension of the shaft 1.

[0066] The measuring arrangement 3 comprises a measuring device 5 which is accommodated within a housing 13. The measuring device 5 is adapted for measuring dimension data relating to objects 35 in an environment surrounding the measuring device 3. In the application described herein, such objects 35 may generally be the walls 19 of the shaft 1.

[0067] As shown in more detail in Fig. 2, the housing 13 has a box shape with a top plate 59 and a bottom plate 61 being mechanically connected with each other via metal rods 57 extending at four edges of the housing 13. Fins 63 protrude in different lateral directions from an upper part of the housing 13. A dampening arrangement 53 comprising for example a cushion is arranged at a lower part of the housing 13. Additionally, dampening arrangements (not shown) may be provided at other parts of the housing 13 such as along an outer surface of the metal rods 57. The housing encloses and protects an inner volume in which the measuring device 5 is accommodated.

[0068] As visualised in Fig. 2 in a schematic manner, the measuring device 5 comprises a range sensing unit 43. Such range sensing unit 43 may be implemented with various techniques or types of apparatuses including an optical scanner device 37, a radar device 39 or a lidar device 41. The measuring device 5 may optionally comprise further components such as an initial motion sensing unit 45 and/or a height determination unit 47. Data from the range sensing unit 43 and/or one of the other units 45, 47 may be processed by a computing unit 49. All these units 43, 45, 47, 49 may be supplied with energy via an energy storage unit 51 including for example a battery. Additionally, the measuring device 5 may have a data memory (not shown) in which data collected from one or several of the units 43, 45, 47, 49 may be stored. Furthermore, the measuring device 5 may comprise a data interface (not shown) via which stored data may be read-out. Additionally or alternatively, a data communication unit (not shown), preferably a wireless data communication unit, for communicating data for example to a remote data processing device 15 may be comprised in the measuring device 5.

[0069] The measuring arrangement 3 further comprises an aerodynamics device 11 which is mechanically coupled to the housing 13. Therein, the aerodynamics device 11 is specifically configured and coupled to the housing 13 in a manner such that it may induce forces onto the housing 13 which may stabilise an orientation of the housing in a situation in which the measuring arrangement is falling along the shaft 1.

[0070] In the example shown, the aerodynamics device 11 comprises both, a streamer 27 as well as a pilot chute 29. However, in an alternative embodiment, the aerodynamics device 11 may comprise only a streamer 27 or only a pilot chute 29. The pilot chute 29 may be deployed from a collapsed configuration to an opened configuration using an activation mechanism 31. The aerodynamics device 11 is coupled to the housing 13 via a string-like connection 33. The string-like connection 33 may comprise one or several lines, ropes, chains or similar deflectable elongate means forming a mechanically loadable interconnection between the aerodynamics device 11 and the housing 13. For example, the string-like connection 33 may be coupled to the housing 13 at a single central location or, preferably, at multiple locations along a circumference of the housing 13. For example, four ropes may be attached, on the one side, to the housing 13 at its four upper corners and, on the other side, to a lowermost connection point at the aerodynamics device 11.

[0071] For measuring the shaft 1, the measuring arrangement 3 is initially arranged at an upper level 7 within the shaft 1. Preferably, the measuring arrangement 3 is engaged with a holding arrangement 17 positioned at the upper level 7. Using such holding arrangement 17 comprising an elongate rod 67 with an engagement and releasing mechanism 65 provided at its distal end, the measuring arrangement 3 may be initially arranged centrally within the shaft 1, i.e. distant from each of the multiple walls 19 of the shaft 1. Starting with such well-defined stationary initial conditions, the measuring arrangement may then be released such as to drop in a falling motion along the shaft 1. Due to gravitational forces, the measuring arrangement 3 is accelerated to substantial velocities. At the same time, the measuring arrangement 3 acquires the dimensions data of the shaft 1 using its measuring device 5. The acquired dimension data may be intermittently stored and/or may be transmitted to the remote data processing device 15. The measured dimension data acquired during the falling motion, i.e. during a non-linear motion, may then be processed and analysed in accordance with known data processing techniques. Additional reflectors or markers arranged at random places or predetermined positions within the shaft 1 may be used for providing additional information which may then be helpful upon processing and analysing the acquired dimension data.

[0072] During the falling motion, the aerodynamics device 11 coupled to the housing 13 of the measuring arrangement 3 induces decelerating drag forces at least partly countering the accelerating vertical gravitational forces. Furthermore, the aerodynamics device 11 may induce guiding forces in a horizontal direction such as to prevent the measuring arrangement 3 from excessively deviating from a vertical travel path centrally along the shaft 1. Due to the forces transmitted from the aerodynamics device 11 via the string-like connection 33 to the housing 13 of the measuring arrangement 3, the housing 13 together with the measuring device 5 is stabilised in its orientation and, additionally, may be prevented from reaching excessive velocities.

[0073] At the end of the falling motion, i.e. upon having travelled along the shaft 1, the measuring arrangement 3 is catched at a lower level 9 within the shaft 1. For such purpose, a catching arrangement 27 is provided at or close to the lower level 9. Such catching arrangement 21 may comprise a cushion 23 formed for example by several pieces of foam filling a pit of the shaft 1. Alternatively or additionally, the catching arrangement 21 may comprise a net 25 spanning the shaft 1.

[0074] The measuring arrangement 3 together with the holding arrangement 17 and the catching arrangement 21 may form components of a measuring kit 55.

[0075] Embodiments of the approach described herein may provide several advantages. For example, a simple use and setup may be enabled. Compared to conventional approaches, relatively short time is needed for taking the shaft measurements. Furthermore, setting up the system is quite simple and does not require for example accurate installation of guiding ropes or similar means. Furthermore, deinstallation or tear-down of the measuring equipment may be simple and the entire system does not need to run for a long time. Furthermore, renovation and installation may be implemented such as to more accurately allowing, inter-alia:

- No time lost due to inaccurate plans.
- No risk of having to adapt mid installation to deformation in the shaft.
- Reduced time to do shaft measurements which are for now done manually.
- Reduce risk of accident by reducing the time spent in the shaft.
- Planning the correct position for the rails and the correct type of elevator is risk free since the shaft is mapped at all points.

[0076] Finally, it should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality. Elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

Claims

1. A method for measuring a shaft (1), particularly an elevator shaft, the method comprising:

   providing a measuring arrangement (3) comprising a measuring device (5) configured for measuring dimension data relating to objects (35) in an environment surrounding the measuring device (5),
   arranging the measuring arrangement (3) at an upper level (7) within the shaft (1),
   releasing the measuring arrangement (3) such that the measuring arrangement (3) drops in a falling motion along the shaft (1),
   acquiring dimension data of the shaft (1) using the measuring arrangement (3) during the falling motion, and
   catching the measuring arrangement (3) after the falling motion at a lower level (9) within the shaft.

2. The method according to claim 1,
   wherein the measuring arrangement (3) comprises an aerodynamics device (11) coupled to a housing (13) accommodating the measuring device (5) of the measuring arrangement (3) and wherein an orientation of the housing (13) is stabilized due to aerodynamic interaction of the aerodynamics device (11) with surrounding air during the falling motion along the shaft (1).

3. The method according to claim 1 or 2,
   wherein the dimension data are at least one of

   - stored during the falling motion and read-out after catching the measuring arrangement (3) for subsequent data processing, and
   - transmitted during the falling motion to a remote data processing device (15).

4. The method according to any of the preceding claims,

   wherein the measuring arrangement (3) is arranged at the upper level (7) within the shaft (1) by engaging the measuring arrangement (3) with a holding arrangement (17) positioned at the upper level (7), the holding arrangement (17) holding the measuring arrangement (3) at a starting position distant from each of multiple walls (19) of the shaft (1), and
   wherein the measuring arrangement (3) is released by disengaging the measuring arrangement (3) from the holding arrangement (17).

5. The method according to any of the preceding claims,
   wherein the measuring arrangement (3) is catched after the falling motion using a catching arrangement (21) including at least one of a cushion (23) arranged within the shaft (1) at a position at or below the lower level (9) and a net (25) spanning the shaft (1) at a position at or below the lower level (9).

6. A measuring arrangement (3) for measuring a shaft (1), particularly an elevator shaft, the measuring arrangement (3) comprising:

   a housing (13),
   a measuring device (5) being accommodated within the housing (13), and
   an aerodynamics device (11) being mechanically coupled to the housing (13),
   wherein the measuring device (5) is configured for measuring dimension data relating to objects (35) in an environment surrounding the measuring device (3),
   wherein the aerodynamics device (11) is configured and coupled to the housing (13) such as to stabilize an orientation of the housing (13) upon the measuring arrangement (3) dropping in a falling motion along the shaft (1).

7. The measuring arrangement according to claim 6, wherein the aerodynamics device (11) comprises a streamer (27).

8. The measuring arrangement according to one of claims 6 and 7,

   wherein the aerodynamics device (11) comprises a pilot chute (29), and
   wherein the measuring arrangement (3) optionally further comprises an activation mechanism (31) for opening the pilot chute (29) during the falling motion.

9. The measuring arrangement according to claim 8, wherein the aerodynamics device (11) is coupled to the housing (13) via a string-like connection (33).

10. The measuring arrangement according to one of claims 6 to 9,
    wherein the measuring device (5) is configured for measuring the dimensions relating to objects (35) in the environment surrounding the measuring device in a contactless manner.

11. The measuring arrangement according to one of claims 6 to 10,
    wherein the measuring device (5) is configured for measuring distances between the objects (35) in the environment surrounding the measuring device (5) and the measuring device (5) itself.

12. The measuring arrangement according to one of claims 6 to 11,
wherein the measuring device (5) comprises at least one of an optical scanner device (37), a radar device (39) and a lidar device (41).

13. The measuring arrangement according to one of claims 6 to 12,
wherein the measuring device (5) comprises at least one of

- a range sensing unit (43),
- an inertial motion sensing unit (45),
- a height determination unit (47),
- a computing unit (49), and
- an energy storage unit (51).

14. The measuring arrangement according to one of claims 6 to 13,
wherein the housing (13) is provided with a dampening arrangement (53) configured for dampening forces upon the measuring arrangement (3) being catched at an end of the falling motion.

15. A measuring kit (55) for measuring a shaft (1), particularly an elevator shaft, the measuring kit (55) comprising:

the measuring arrangement (3) according to one of claims 6 to 14, and
at least one of

- a holding arrangement (17) configured to be positioned at the upper level (7) and hold the measuring arrangement (3) at a starting position distant from each of multiple walls (19) of the shaft (1) and releasing the measuring arrangement (3) by disengaging the measuring arrangement (3) from the holding arrangement (17),
- a catching arrangement (21) including at least one of a cushion (23) configured for being arranged within the shaft (1) at a position below the lower level (9) and a net (25) configured for spanning the shaft (1) at a position below the lower level (9).

Fig. 1

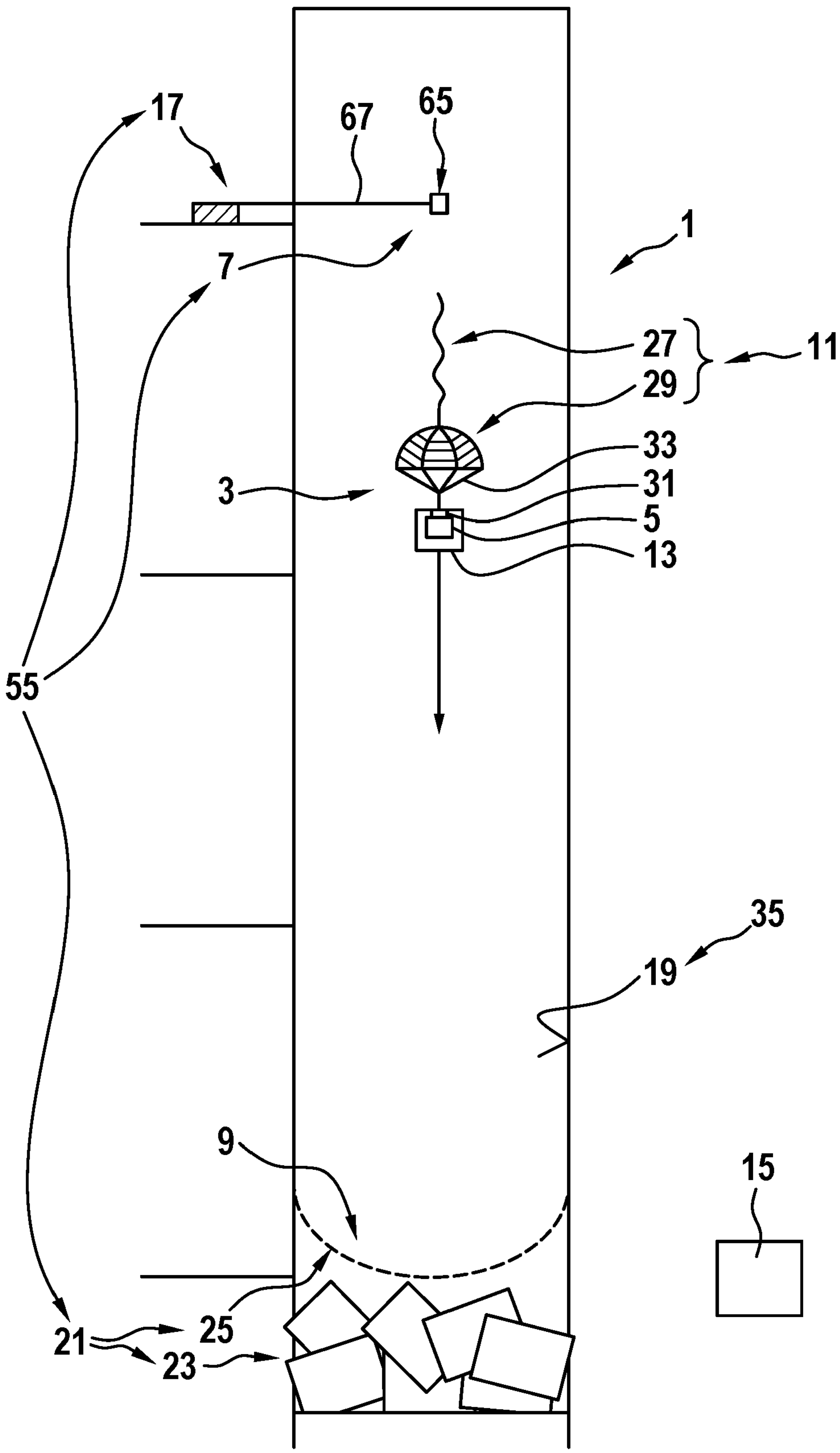
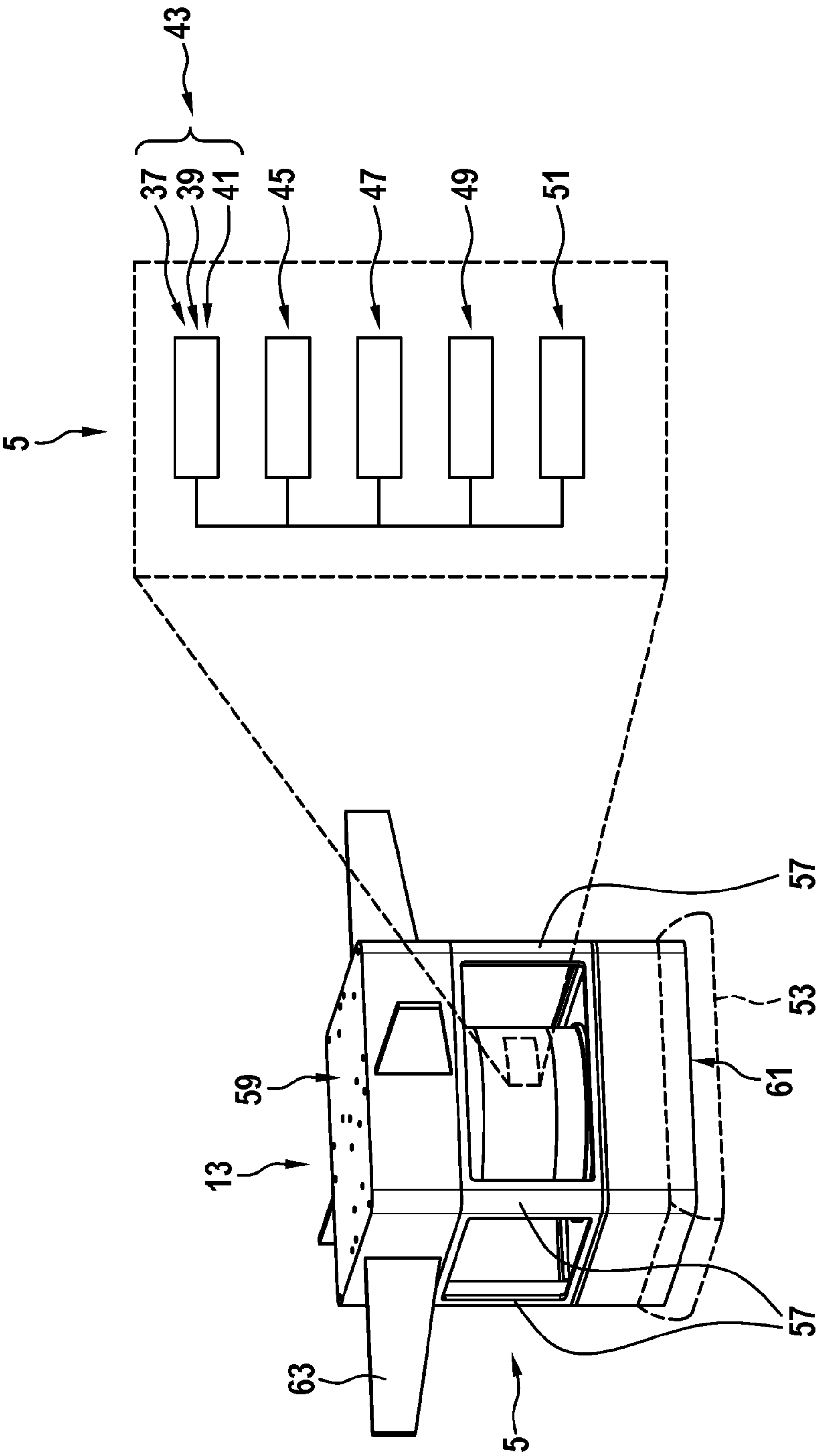


Fig. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 8207

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X A	GEOSPATIAL WORLD: "LiDAR USA now offers drone rescue parachute option", geospatialworld.net, 1 July 2019 (2019-07-01), XP093069104, Retrieved from the Internet: URL:https://www.geospatialworld.net/news/lidar-usa-now-offers-drone-rescue-parachute-option/ [retrieved on 2023-07-31] * the whole document *	6,8-14 1-5,7,15	TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	1 August 2023	Bleys, Philip

CATEGORY OF CITED DOCUMENTS

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REFERENCES CITED IN THE DESCRIPTION

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