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(54) **CONTAINER DEVICE FOR TRANSPORTING A COIL, SYSTEM AND METHOD**

(57) The disclosure relates to a container device (1) for transporting a coil (2), the coil (2) comprising a center pin (3) on which a moisture-sensitive foil (4) is wound. In order to overcome present disadvantages and establish a solution for safe, reliable and sustainable transportation of moisture sensitive foils, e.g. electrodes and electrode materials, in between "mini-environments", i.e. small dry room environments, a means for transporting a coil (2) in a dry or very dry atmosphere is required. For this reason, the container device (1) comprises: a base plate (5) and a cover (6) configured to be removably positioned on the base plate (5), such that the base plate (5) and the cover (6) enclose the coil (2) in a gas-tight manner, and supports (7) projecting upwards from the base plate (5) into the container and configured to support the center pin (3) of the coil (2).

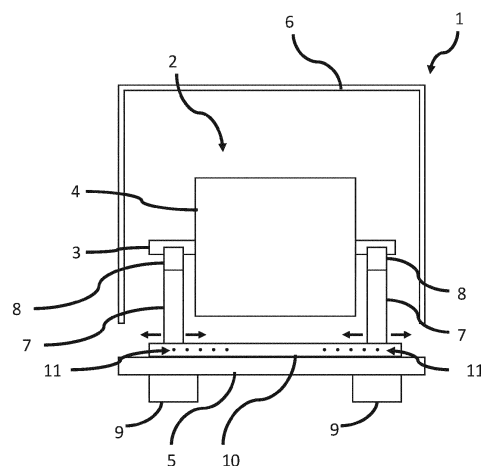


Fig. 2

Description

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to a container device for transporting a coil.

BACKGROUND

[0002] Batteries play a critical role in modern society, powering a wide range of devices from portable electronics to electric vehicles. Rechargeable batteries, also referred to as secondary batteries, are often preferred due to their reusability. Furthermore, the shift towards renewable energy sources such as solar and wind power has increased the need for energy storage systems, making batteries an essential technology in the transition to a low-carbon economy.

[0003] A battery cell consists of two electrodes and a separator that separates the electrodes from each other. Battery electrodes are conductive components that serve as the positive and negative terminals in a battery. Between the two electrodes is an ion-conducting electrolyte which ensures a high ion flow between the electrodes. Secondary batteries are based on the principle of moving metal ions as charge carriers from a cathode to an anode and vice versa.

[0004] A positive electrode, or cathode, is usually a foil or sheet component having a negative potential. In conventional lithium-ion battery cells, the positive electrode may consist of a 10 - 25 μm thick aluminum foil as current collector, an active material like for example Lithium-Nickel-Manganese-Cobalt-Oxide (NMC), and additives. A negative electrode, or anode, is usually a foil or sheet component having a negative potential. The negative electrode may consist of an 6 - 18 μm thick copper foil, which is coated with an active material like for example graphite and additives.

[0005] Typically, the manufacturing process of a battery cell may comprise the following steps (or stages, used interchangeably in the present disclosure): mixing of the active material, the solvent, the binder and the additives (resulting in an electrode slurry or slurry); coating the substrate foil with the slurry; drying of the coated substrate foil; calendaring and slitting of the substrate foil; vacuum drying of the substrate foil; cutting and stacking of the electrode foil with a separator; packaging the electrode-separator-assembly; and filling of the packages with an electrolyte filling.

[0006] As energy consumption and renewable energy production increase, the demand for secondary batteries increases as well. To meet the demand, global battery cell production capacity is expected to increase by a factor of 5 between 2022 and 2030. One of many challenges of the necessary ramp up of production capacity is the availability of appropriate production facilities. In particular, sufficient dry and clean room facilities are required and highly sought after.

[0007] Many steps of the manufacturing of a battery cell require a dry and/or clean room environment. Active materials of an electrode are very sensitive to moisture and experience a permanent performance reduction when getting into contact with water either directly or indirectly. This performance decrease may already occur when the electrode is manufactured in a humid environment. Depending on the kind of active material of an electrode and the additives and the solvents used in the production process, the production environment must be dry to very dry.

[0008] As an example, an electrode with an N-methyl-2-pyrrolidone (NMP) based slurry typically requires a very dry environment most or all aforementioned manufacturing steps.

[0009] Within the present disclosure, the terms "dry environment" and "very dry environment" will be used unanimously. Typically, an environment with a dew point of 0°C to - 30°C may be considered a dry environment. An environment with a dew point of - 30°C to - 60°C may be considered a very dry environment. The dew point reflects the humidity of the respective body of air that is measured. Generally, the dew point is the temperature to which the air must be cooled to become saturated with water vapor. When the air of said body of air is cooled below the dew point, its moisture capacity is reduced, and airborne water vapor will condense.

[0010] A dry room is a room with a controlled environment. In particular, the humidity of the environment is precisely controlled. To control the humidity of the environment, the air enclosed in the dry room must be dried continuously. This may be carried out with a condensation step, wherein the air is removed from the dry room, cooled until the moisture in the air condensates and can be removed, and afterwards reintroduced into the dry room. The drying may also include an adsorption step, wherein specially coated drying wheels remove the moisture from the air in the drying room. This may for example be carried out with a fiber fleece, which has a structure of bonded silica gel and metal silicate that absorbs the moisture.

[0011] Although the technology required for the drying of the air is becoming increasingly efficient, the process remains very energy intensive. Furthermore, the machinery itself requires a lot of room.

[0012] As the aforementioned manufacturing steps of the batteries are often carried out in the form of roll-to-roll processes, the production machinery may require a spacious room or hall. Furthermore, the materials must be moved from one machine to another in between manufacturing steps. Insofar, a dry room environment needs to cover the production machinery and also the pathways along which the materials, e.g. the electrodes, are transported.

[0013] As dry rooms require a lot of energy and space, it is preferable to reduce the need for dry rooms as much as possible. In particular, unnecessary space of dry room, for example transportation pathways, must be

avoided or reduced to a minimum.

SUMMARY OF THE DISCLOSURE

[0014] Currently, it remains desirable to overcome the aforementioned problems and in particular to provide a solution which allows reducing the size of dry rooms.

[0015] Therefore, the present disclosure relates to a container device for transporting a coil, the coil comprising a center pin on which a moisture-sensitive foil is wound, comprising:

a base plate and a cover configured to be removably positioned on the base plate, such that the base plate and the cover enclose the coil in a gas-tight manner, and supports projecting upwards from the base plate into the container device and configured to support the center pin of the coil.

[0016] By providing such a container device, a coil, in particular an electrode coil, can be stored and transported in a dry, safe and clean environment. Accordingly, in order to reduce dry room requirements, smaller, isolated manufacturing and/or dry room environments can be established. Such a small dry room environment, also called "mini-environment", may for example encapsulate the machinery for one specific manufacturing step, but may not encapsulate any further space.

[0017] While these "mini-environments" allow reducing the dry room capacity drastically, the container device of the present disclosure provides a safe, reliable and sustainable solution for a dry transport of electrodes and other moisture sensitive active materials in between said "mini-environments". In other words, by providing such a container device, a device for safe, reliable and sustainable transportation of moisture sensitive electrodes and electrode materials in between mini-environments, e.g. dry room environments for particular manufacturing steps, is obtained what allows a significant reduction of the total size of dry rooms.

[0018] A coil may comprise a moisture sensitive foil. A moisture sensitive foil may be an electrode foil, in particular an electrode foil for use in a battery, e.g. a secondary battery or a super capacitor. An electrode foil may be a 10 - 25 μm thick aluminum foil comprising an active material, like for example Lithium-Nickel-Manganese-Cobalt-Oxide (NMC), solvents, like for example N-methyl-2-pyrrolidone (NMP) and further additives. Other material combinations and/or dimensions are possible. An electrode foil may comprise a very low thickness relative to its other dimensions. An electrode foil may comprise a defined width and a length. An electrode foil may have a large length relative to its other dimensions and may be wound up on a coil.

[0019] An electrode foil may in particular be positioned in a container device before and/or after slitting of the electrode foil. In case an electrode foil is transported after

slitting, i.e. slitting the foil of one "mother" coil into 2 or more smaller "child" coils, the slitting e.g. lengthwise to reduce the width of a coil, one or several of the smaller "child" electrode coils may be wound on the same center pin.

[0020] A foil may in particular be an electrode foil, or a semi-finished electrode product, in any of the stages within an exemplary manufacturing process described above.

[0021] In particular, the active material of an electrode foil, e.g. graphite or NMC, and/or the solvent of the electrode slurry, e.g. NMP, may be moisture sensitive.

[0022] A center pin of a coil may comprise or may be a hollow piece of metal, e.g. aluminum or stainless steel. A center pin may also be a solid piece of metal. A center pin may also partially or completely consist of plastic, carbon fiber and/or glass fiber. A lightweight material, in particular e.g. aluminum or carbon fiber, is desirable as the total weight of the coil and thus the container device to be transported can be kept low.

[0023] A center pin may also comprise a hollow or solid shaft and a hollow cylinder, wherein the hollow cylinder may be designed to accommodate the shaft in it. Insofar, the shaft may be positioned in the opening of the hollow cylinder. The diameter of the shaft may be increased, for example by means of compressed air, so that it is firmly positioned in the hollow cylinder and may thus rotationally fix the hollow cylinder to the shaft through friction, i.e. through force locking. The hollow cylinder and thus the coil can hence be rotated by the shaft.

[0024] A base plate may be a rectangular sheet of metal, e.g. of aluminum or stainless steel. Desirably, a base plate may comprise a base area corresponding to approximately the size of a EURO pallet or in particular half a EURO pallet.

[0025] A base plate may comprise a guiding frame or on one or multiple guiding rails for a cover. Such a guiding frame or such guiding rails may for example protrude upwards, i.e. in the direction of the cover, from the sides or in particular the top of the base plate. The cover may sit outside or inside of this guiding frame or these guiding rails. By providing such a guiding frame or such guiding rails, an easier montage and a better hold of a cover on a base plate may be achieved.

[0026] One or more gaskets or seals, e.g. an O-ring or a strip, may be provided on a base plate to secure a gas-tight connection between the base plate and the cover. A gasket or seal may for example sit inside a groove of a base plate. A gasket or seal may also be provided alongside a guiding frame or a guiding rail or on the sides or the top of a base plate. A gasket or seal may for example comprise rubber or fiber.

[0027] A gas-tight manner may refer to a normal, atmospheric pressure within the container device. Desirably, a gas-tight manner may refer to an overpressure within the container device. By providing an overpressure in the container device, moisture can be kept from entering the container device.

[0028] A cover may have the shape of a hood. The cover may hence also be referred to as a hood cover or hood. The cover may also have a cuboid form with merely 5 covered sides. A cuboid cover may thus be "open" to one side, desirably the bottom side.

[0029] A cover may in particular comprise a footprint (i.e. a bottom side) identical or at least similar to that of a base plate. Insofar, the cover can fit seamlessly on the base plate. Thus, a smooth container device can be obtained with no protruding edges, thus being easily movable, arrangeable and stackable.

[0030] A cover may be transparent or partially transparent. It may merely include transparent areas, e.g. glass or plastic windows, to enable a look inside the container device from the outside. Insofar, it becomes easily assessable whether the container device is loaded with a coil or not. Furthermore, a cover may comprise a moisture-strip inside the cover to easily assess a moisture level from the outside. Insofar, such a moisture strip may be positioned on an transparent part of a cover.

[0031] A cover may comprise a metal such as e.g. aluminum or stainless steel. A cover may also comprise plastic or fiber. Combinations thereof are also possible. A cover may in particular comprise glass or transparent plastic.

[0032] Handling means for lifting and transporting of the cover, e.g. handling bars or hooks, may also be comprised on the outside of the cover.

[0033] A cover may also comprise stacking rails on its outside, in particular on the upper side of the cover. These stacking rails may be used to stack multiple container devices on top of one another. Insofar, the stacking rails may be configured such that they can fit a base plate of another container device and/or a substructure of a base plate of another container device. By including such stacking rails, multiple container devices may be stacked on top of one another in a mechanically stable manner.

[0034] In one example, a cover may also comprise an opening, e.g. an inlet, configured to accommodate a pipe and/or a tube for flooding the enclosed room with an inert gas such as e.g. helium, neon or argon. Such an opening may also comprise a valve, particularly a one-way valve.

[0035] A container device may comprise one or more, in particular two, supports for the coil. Typically, these e.g. two supports are arranged in such a way that they can support, in particular hold, a center pin on opposite sides of the corresponding coil.

[0036] A support may be a metal structure resembling a pillar or a leg. A support may comprise two ends, wherein one end is directly or indirectly connected to a base plate and the other end is connected to the center pin. Such a connection may comprise a bracket and/or a holder and/or an adapter for a center pin. Such a bracket may in particular prevent any movement of a therewith connected center pin in axial and/or radial direction. It may furthermore prevent any rotation of the center pin.

[0037] A bracket of a support may be configured to lock a center pin, e.g. in a form-lock. It may also be configured

to merely support or carry a center pin without locking it. However, a bracket that is configured to lock a center pin may be desirable in particular with regards to an ensuing transportation of the container device, as it ensures a more reliable hold.

[0038] A support may protrude upwards from the base plate with a length that is sufficient to ensure that a coil supported by said support, in particular a foil wound up on the coil, may not touch the base plate. Desirably, a support may also be configured such that a coil and in particular a wound-up foil on said coil does not touch said support.

[0039] A cover may be removably positioned on a base plate. Insofar, a coil can be placed on top of a base plate and the base plate can be covered with a cover so that the base plate and the cover enclose the coil in a gas-tight manner. By loading a container device with a coil within a dry room environment in such a manner and afterwards positioning the cover on the base plate to enclose the coil in a gas-tight manner, a dry atmosphere within the container device, i.e. around the coil, can be ensured. Thus, the coil within the container device can be transported from a first mini-environment, i.e. manufacturing dry room environment, to a second mini-environment. The second mini-environment may close to the first mini-environment in the same production site but for example in another building. Alternatively, the second mini-environment may also be geographically distanced from the first mini-environment, for example located in a different production site.

[0040] A base plate may also comprise one or multiple fastening means to fasten a cover to the base plate. A base plate may also comprise one part of a two-part fastening means. In so far, one part of the two-part fastening means, may be provided on, for example, the side of a base plate, wherein the other part of the two-part fastening means, may be provided on the cover. The two parts of the two-part fastening means interact such that the connection between the base plate and the cover can be tightened, in particular to a gas-tight manner.

[0041] An exemplary two-part fastening means may be a spring lock or a threaded coupling lock. By providing such a two-part fastening means a gas-tight connection can be ensured between the base plate and the cover. For example, by providing one or multiple spring locks, a force can be applied on a cover that clamps the cover into a gasket provided on the base plate.

[0042] A two-part fastening means may also comprise a spring-loaded hook positioned on either a base plate or a cover, that snaps into a corresponding ledge positioned on the respective other component, i.e. base plate or cover. A spring-loaded hook may in particular be triggered by a contact between base plate and cover, e.g. via a touch and/or pressure sensitive sensor or lever. Such a fastening means can be tightened automatically when the cover is positioned on the base plate.

[0043] A container device may also comprise a drying

agent, i.e. desiccant, like silica gel. Such a drying agent may desirably be arranged on the base plate and close to the supports such that it does not contact a coil supported on the supports or a foil wound up on said coil. By including such a desiccant agent in the container device, a dry environment may be ensured.

[0044] A cover may enclose the coil on the top and on lateral sides, and/or the cover may only have one opening which is designed to fit together with the base plate, so that the coil is completely enclosed.

[0045] A cover may for example comprise a cuboid form with merely 5 sides. A cuboid cover may thus be "open" to one side, e.g. the bottom side of the cover. The base plate may thus be situated exclusively underneath a supported coil.

[0046] Loading of an exemplary container device may thus comprise positioning a coil onto the supports so that the supports hold the center pin of the coil and afterwards positioning and possibly fastening a cover on top of said base plate. A cover may thus be moved from above the coil onto the base plate, the coil fitting through the opening on the bottom side of the cover.

[0047] A cover may in particular comprise a footprint identical or at least similar to that of a base plate. Insofar, the cover can fit seamlessly on the base plate. The base plate may fit within the sides of the cover. Desirably, the cover may sit on top of the base plate wherein the sides of the cover are flush with the sides of the base plate. The base plate thus "completing" the cuboid form of the cover on the bottom side of the cover. Thus, a smooth container device can be obtained with no protruding edges, hence being easily movable, arrangeable and stackable.

[0048] The supports may be arranged inside the cover, when the cover is positioned on the base plate, and/or each support may have a recessed or U-shaped holder configured to hold the center pin.

[0049] By arranging the supports so that they are inside the cover when the cover is positioned on the base plate, the center pin and/or the coil supported by the supports do not come in contact with the cover. Insofar, a less complex construction of the container device and in particular the cover may be achieved. Furthermore, a sleek construction of the container device without any protruding edges can be obtained, which may be desirable during transportation of a container device.

[0050] A U-shaped holder may be a holder that has two free ends protruding upwards and meeting in a half circle on the opposite side, e.g. a half ring. Insofar, a coil, i.e. a center pin, may be positioned in between the two free ends from above and then may be rested upon the described half ring. Such a holder may be an easy to manufacture component to hold a center pin. Furthermore, loading of the container device may be achieved by simply lowering the center pin of a coil in between the two free ends of a U-shaped holder. The U-shaped holder may optionally comprise a locking device to lock a mounted center pin, such that the center cannot accidentally slip out of the holder, e.g. during transportation.

[0051] The distance of the supports to each other may be adjustable, such that the supports can support center pins of different lengths.

[0052] In order to be able to accommodate different sizes of coils and/or center pins of different lengths, supports may be connected to a base plate in a way that is easily removable and or easily adjustable.

[0053] A support may for example be attached to a rail, the rail being attached to the base plate. Such a rail may allow a sliding of a support, e.g. sliding in the axial direction of a center pin. When adjusted to the length of a center pin of a coil, a support may be locked at a position of such a rail by e.g. a clamp force or a form-lock e.g. with a pin or screw. Such a rail may for example comprise multiple evenly spaced and horizontally aligned holes through which a support may be fastened to the rail. A support may in particular be easily releasable from such a locked position in order to for example be repositioned and adjusted to the specific length of a coil or in particular a center pin of a coil.

[0054] In one example, a base plate may comprise multiple evenly spaced holes, for example holes comprising a thread. A support can easily and quickly be fastened to a pair of holes by means of for example a screw. A support can also easily and quickly be unfastened and moved to a different pair of holes in order to accommodate a coil with a center pin of a different length.

[0055] Other means of fastening are also possible.

[0056] The container device may be a passive device without energy, gas or air supply, such as an internal or external power, gas or air source.

[0057] A passive container device may denote a container device not comprising for example a motor, a heat pump or a condenser.

[0058] An exemplary passive container device may be desirable as a passive device may be transported without the necessity of providing e.g. a power source during the transport. Furthermore, the complexity of a passive container device can be kept low to achieve a simple and resource efficient manufacturing process and also simpler handling of the container device. Additionally, a passive device requires less maintenance and is easily replaceable.

[0059] A base plate may have a substructure, such as feet, configured such that a lifting device can pass underneath and lift the base plate.

[0060] A base plate may for example have feet, skids, runner and/or a different kind of substructure that allows a lifting device to pass underneath and lift the base plate. A substructure may in particular be designed so that the fork of a forklift may pass underneath and lift the base plate.

[0061] A lifting device may be for example a forklift or a different lifting and transport vehicle, desirably in a customized size, e.g. smaller than a conventional forklift that transports EURO pallets. In particular, a lifting device may be of a customized size for lifting half-sized Euro pallets. The lifting and transport vehicle can e.g. drive

autonomously or may be remote-controlled.

[0062] Optionally, a base plate and/or a cover may also comprise loops for attaching of a crane or desirably handles for carrying.

[0063] By providing such a substructure, in particular a substructure for a fork of a forklift, easy transportation along the existing transportation infrastructure, e.g. containers and/or heavy-duty trucks, can be ensured.

[0064] In one example, a container device may comprise a sensor configured to detect moisture in the atmosphere of the container.

[0065] Desirably, such a sensor may be positioned so that it does not touch the coil or in particular the foil wound upon the coil. For example, a sensor may be positioned on the base plate, e.g. in proximity of the supports.

[0066] A sensor configured to detect moisture may be configured to measure traces of humidity in the air enclosed in the container device. A sensor may in particular be configured to measure humidity and report a dew point for the measured environment, i.e. the air in a container device. A sensor may in particular be configured for continuous monitoring of the dew point in the air enclosed in a container device.

[0067] By providing such a sensor, a defective container device, e.g. an insufficient air seal between base plate and cover, may be recognized and possibly repaired. If for example a container device is not sufficiently gas-proof and thus the environment within the container device is not dry within the limits of the corresponding foil within the container device during transportation, the foil within may be sorted out as reject before further manufacturing steps are conducted.

[0068] In one example, a sensor may comprise a sensitivity down to a dew point of -10°C . If such a sensor measures a dew point of -10°C within the enclosed air of a container device, the coil within said container device may be contaminated with moisture. As a general target for a dew point in such an environment is -45°C .

[0069] Desirably, a sensor may be configured to measure a humidity up to a dew point of -45°C and possess a sensitivity of plus or minus 10°C .

[0070] A sensor may function according to one of the following principles: capacitive air humidity measurement, psychrometric air humidity measurement, or hygrometric air humidity measurement.

[0071] A sensor may also be or comprise a measuring strip, in particular a humidity indicator strip or humidity indicator card. Such an indicator provides quickly and easily readable measuring data of the humidity within the enclosed environment.

[0072] The moisture-sensitive foil may be an electrode foil, such as a cathode foil.

[0073] An electrode foil may in particular be an electrode foil for a battery cell and or a super capacitor.

[0074] An electrode foil may for example be a coated foil, wherein the coating may comprise nickel. Nickel is very humidity sensitive and will suffer great efficiency losses when contaminated with water, e.g. through an

environment with a dew point higher than -45°C .

[0075] An electrode foil may also comprise silicon. Silicon is very sensitive to moisture. Indeed, silicon as an active material in e.g. the anode may be coated and thus passivated against water (the slurries may be e.g. water-based). However, a relatively large amount of binder may be used for the silicon anode and this absorbs moisture. The moisture must thus be dried and removed at great expense before the cells are built.

[0076] Otherwise, the electrode foil may experience a permanent performance reduction, when getting into contact with water either directly or indirectly. This performance decrease may also occur when the electrode foil is manufactured in a humid environment. Depending on the kind of active material of an electrode foil and the additives and in particular the solvents used in the production process, the production environment must be dry to very dry.

[0077] As an example, an electrode with an N-methyl-2-pyrrolidone (NMP) based slurry typically requires a very dry environment most or all aforementioned manufacturing steps.

[0078] An electrode foil may require a dry or very dry environment during some, optionally all of the following manufacturing steps: mixing of the active material, the solvent, the binder and the additives (resulting in an electrode slurry or slurry); coating the substrate foil with the slurry; drying of the coated substrate foil; calendaring and slitting of the substrate foil; vacuum drying of the substrate foil; cutting and stacking of the electrode foil with a separator; packaging the electrode-separator-assembly; and filling of the packages with an electrolyte filling.

[0079] An electrode foil may in particular be positioned in a container device before and/or after slitting of the electrode foil. In case an electrode foil is transported after slitting, i.e. slitting the foil of one "mother" coil into 2 or more smaller "child" coils, the slitting e.g. lengthwise to reduce the width of a coil, one or several of the smaller "child" electrode coils may be wound on the same center pin.

[0080] The present disclosure further relates to a system for winding and transporting a coil, comprising: a winding device configured to wind a center pin of the coil with a moisture-sensitive foil, the container device according to any one of the aforementioned container devices, a lifting device configured to lift the base plate, and optionally a closing device configured to position the cover on the base plate in a gas-tight manner.

[0081] Such a system may be used within the manufacturing of a battery cell and/or an electrode foil for a battery cell. A desirable stage within the manufacturing process of a battery cell may for example be immediately before or after a slitting stage.

[0082] A coil with a moisture-sensitive foil may in particular be a coil with an electrode foil, in particular an electrode foil for use in a battery, e.g. a secondary battery or a super capacitor. An electrode foil may be a 10 - 25

μm thick aluminum foil comprising an active material, like for example Lithium-Nickel-Manganese-Cobalt-Oxide (NMC), solvents, like for example N-methyl-2-pyrrolidone (NMP) and further additives. Other material combinations and/or dimensions are possible. An electrode foil may comprise a very low thickness relative to its other dimensions. An electrode foil may comprise a defined width and a length. An electrode foil may have a large length relative to its other dimensions and may be wound up on a coil.

[0083] A winding device may comprise a shaft for mechanically connecting with a center pin of a coil. Such a connection may for example be a friction lock, wherein the shaft of the winding device may be positioned inside a hollow center pin and afterwards expanded to create the frictional force for the friction lock. A winding device may also comprise one or multiple brackets for mechanically connecting with a center pin of a coil, in particular with the sides of a center pin of a coil.

[0084] A motor may be provided within the winding device for directly or indirectly rotating the center pin of a coil. In particular, an electric motor may be desirable.

[0085] A lifting device may be a forklift. A fork of a forklift may be adjusted to a substructure of a base plate. A lifting device may also be a moveable forklift, in particular an autonomously movable forklift.

[0086] Optionally, a closing device may be comprised in the system. Such a closing device may be configured to position the cover on the base plate in a gas-tight manner. For example, a closing device may be configured to grab a cover from a first position and move, lift and/or rotate said cover to position it above a base plate and a coil supported on said base plate. Furthermore, such a closing device may be configured to lower a cover on a base plate and desirably exert a pressure force on the cover so that the cover and the base plate may be connected in a gas-tight manner. Optionally, a closing device may be configured to fasten one or more fastening means, in particular spring-loaded fastening means.

[0087] In one example, a closing device may comprise one or multiple robot arms.

[0088] A system may further comprise a dry room in which is arranged: the winding device, the container device, the lifting device, and the optional closing device.

[0089] Such a dry room may in particular be configured to establish a dry or very dry environment. A dry or very dry environment may be for example an environment with a dew point of 0°C to -30°C, in particular with a dew point of -30°C to -60°C. The dew point reflecting the humidity of the respective environment.

[0090] Insofar, such an environment may be suited for the manufacturing of moisture-sensitive electrode foils.

[0091] Such a system, i.e. a system for winding and transporting a coil comprised within a dry room environment, may be considered a "mini-environment".

[0092] A System may be configured so that, when the moisture-sensitive foil is wound on the center pin: the lifting device positions the base plate without the cover

below the coil and lifts the base plate such that the supports engage with and support the center pin of the coil and at the same time the center pin disengages from the winding device, the lifting device removes the base plate and the supported coil from the winding device, optionally the closing device positions the cover on the base plate, such that the base plate and the cover enclose the coil in a gas-tight manner, and optionally the lifting device transports the container device out of the dry room.

[0093] By configuring a system in such a manner, a coil comprising moisture-sensitive foil, e.g. comprising an electrode foil, can, immediately after being wound, for example after a slitting stage, be transferred into a container device. Inside the container device is a dry or very dry environment, as the gas-tight closing of the cover on the base plate of the device was conducted in a dry or very dry environment, i.e. the dry room. The electrode foil can thus be transported out of the dry environment of the system, e.g. out of the "mini-environment", and optionally transferred to another "mini-environment", possibly for a next manufacturing step.

[0094] The present disclosure further relates to a method of inserting a coil into a container device, the coil comprising a center pin on which a moisture-sensitive foil is wound, the container device comprising a base plate, a cover configured to be removably positioned on the base plate and supports projecting upwards from the base plate into the container, the method comprising:

positioning the base plate without the cover below the coil,
lifting the base plate such that the supports engage with and support the center pin of the coil and at the same time the center pin disengages from a winding device,
removing the base plate and the winding device from each other, and
positioning the cover on the base plate, such that the base plate and the cover enclose the coil in a gas-tight manner.

[0095] A container device may in particular be one of the afore mentioned container devices.

[0096] A moisture sensitive foil may in particular be an electrode foil for use in a battery, e.g. a secondary battery or a super capacitor. An electrode foil may be a 10 - 25 μm thick aluminum foil comprising an active material, like for example Lithium-Nickel-Manganese-Cobalt-Oxide (NMC), solvents, like for example N-methyl-2-pyrrolidone (NMP) and further additives. Other material combinations and/or dimensions are possible. An electrode foil may comprise a very low thickness relative to its other dimensions. An electrode foil may comprise a defined width and a length. An electrode foil may have a large length relative to its other dimensions and may be wound up on a coil.

[0097] The method may be carried out using one of the

aforementioned systems.

[0098] While positioning the base plate below the coil, the base plate may be positioned so that the supports are aligned with the center pin of the coil for easy connecting, lifting and holding.

[0099] While removing the base plate and the winding device from each other, the winding device may be removed from the lifting device. It is also possible, that the lifting device is removed from the winding device.

[0100] A gas-tight manner may refer to a normal, atmospheric pressure within the container device. Desirably, a gas-tight manner may refer to an overpressure within the container device. By providing an overpressure in the container device, moisture can be kept from entering the container device.

[0101] By such a method, a coil comprising moisture-sensitive foil, e.g. comprising an electrode foil, can, immediately after being wound, for example after a slitting stage, be transferred into a container device. Inside the container device is a dry or very dry environment, as the gas-tight closing of the cover on the base plate of the device was conducted in a dry or very dry environment, i.e. a dry room. The electrode foil can thus be transported out of the dry environment of the system, e.g. out of the "mini-environment", and optionally transferred to another "mini-environment", possibly for a next manufacturing step.

[0102] A method may further comprise transporting the container device to another location, such as to another dry room.

[0103] Another dry room may in particular be a dry room for carrying out one of the manufacturing steps of a battery cell. Thus, another dry room may in particular be another "mini-environment".

[0104] The method may comprise, before positioning the base plate, winding the moisture-sensitive foil on the center pin by means of the winding device.

[0105] The method may further comprise before winding the moisture-sensitive foil: inserting the container device into the dry room with the cover being removed from the base plate.

[0106] Thus, the container device can be easily flooded with dry air, ensuring a dry environment within the container device. If the container device is loaded with a coil within a dry environment, and the cover is applied to the base-plate in a gas-tight manner within said dry environment, the environment within the container device will automatically be a dry environment.

[0107] The technology provided by the present disclosure may be applied in the production of various types of batteries such as lithium-ion secondary batteries. In particular to such batteries containing nickel or other moisture-sensitive materials. Other compatible examples of batteries may be sodium-ion batteries, potassium-ion batteries, magnesium-ion batteries, calcium-ion batteries, magnesium-sulfur batteries, or aluminum-ion batteries. The technology provided by the present disclosure may also be applied in various types of metal ion capacitors, such as lithium-ion capacitors.

citors, such as lithium-ion capacitors.

[0108] It is intended that combinations of the above-described elements and those within the specification may be made, except where otherwise contradictory.

[0109] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only, are provided for illustration purposes, and are not restrictive of the disclosure, as claimed.

[0110] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate examples of the disclosure and together with the description and serve to support and illustrate the principles thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0111]

Fig. 1a schematically shows an example of a container device according to examples of the present disclosure in a front view.

Fig. 1b schematically shows the example of fig. 1a in a side view.

Fig. 2 schematically shows an example of a container device according to examples of the present disclosure in a front view.

Fig. 3 schematically shows an example of a container device according to examples of the present disclosure in a front view and also a detail view.

Fig. 4a schematically shows an example of a closed container device according to examples of the present disclosure in a front view.

Fig. 4b schematically shows the example of fig. 4a in a side view.

Fig. 5 schematically shows an example of a coil held in a manufacturing machinery and an opened container device according to examples of the present disclosure in a front view.

DESCRIPTION OF THE DRAWINGS

[0112] Reference will now be made in detail to examples of the disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0113] In figures 1 to 4 is shown a container device 1 for transporting a coil 2. The coil 2 comprises a center pin 3 on which a moisture-sensitive foil 4 is wound.

[0114] The container device 1 comprises a base plate 5 and a cover 6. The cover 6 is configured to be removably positioned on the base plate 5, such that the base plate 5 and the cover 6 enclose the coil 2 in a gas-tight manner.

[0115] A coil 2 may comprise a moisture-sensitive foil 4, wherein a moisture sensitive foil 4 may be an electrode foil, in particular an electrode foil for use in a battery, e.g. a secondary battery or a super capacitor.

[0116] The center pin 3 of the coil 2 is a hollow piece of metal, e.g. aluminum or stainless steel, in a cylindrical form. This is in particular shown in fig. 1b. A center pin 3 may generally also partially or completely consist of plastic, carbon fiber and/or glass fiber.

[0117] The cover 6 has a cuboid form with five sides and is thus "open" to one side, i.e. the bottom side.

[0118] The cover 6 comprises a footprint, i.e. bottom side, identical to that of the base plate 5. Insofar, the cover 6 fits seamlessly on the base plate 5. Thus, a smooth container device 1 can be obtained with no protruding edges, thus being easily movable, arrangeable and in particular stackable.

[0119] The base plate 5 is shown as a rectangular sheet of metal, e.g. of aluminum or stainless steel. The base plate 5 may comprise a base area corresponding to approximately the size of a EURO pallet or in particular half a EURO pallet

[0120] The container device 1 is a passive container device 1. Insofar, it does not comprise for example a motor, a heat pump or a condenser.

[0121] In figures 1a to 4b is shown a base plate 5 comprising a substructure 9, configured such that a lifting device can pass underneath and lift the base plate 5.

[0122] The shown substructures 9 are designed as feet or skids that extend along the complete base plate 5 as can be seen in fig. 1b. The substructures 9 are also designed so that they allow a fork of a forklift to pass underneath and lift the base plate 5.

[0123] The cover 6 shown in fig. 1a and fig. 1b as well as fig. 2 and fig. 3 is completely transparent. The cover 6 may for example be made of glass. Insofar, it is easily assessable whether the container device 1 is loaded with a coil 2 or not.

[0124] In fig. 1a and fig. 1b, as wells as in fig. 2 and fig. 3, two supports 7 are shown that project upwards from the base plate 5 into the container device 1. These supports 7 are configured to support the center pin 3 of the coil 2.

[0125] The supports 7 protrude upwards from the base plate 5 with a length that is sufficient to ensure that the coil 2 supported by said supports 7 and in particular a foil 4 wound up on said coil 2 do not touch the base plate 5. The supports 7 are also configured such that the coil 2 and in particular the foil 4 do not touch said supports 7.

[0126] The supports 7 are arranged in such a manner, that they are inside the cover 6 when the cover 6 is positioned on the base plate 5, the center pin 3 and the coil 2 supported by the supports 7 do not come in contact with the cover 6.

[0127] Loading of the container device 1 may thus comprise positioning a coil 2 onto the supports 7 so that the supports 7 hold the center pin 3 of the coil 2 and afterwards positioning and possibly fastening the cover 6 on top of said base plate 5. The supports 7 may also be positioned under a coil 2 and afterwards raised to "pick up" the coil 2. The cover 6 may thus be moved from above the coil 2 onto the base plate 5, the coil 2 fitting through the opening on the bottom side of the cover 6.

[0128] As shown in fig. 1a and fig. 1b, as wells as in fig. 2 and fig. 3, the supports 7 are metal structures resembling a pillar or a leg. Insofar, the supports 7 comprise two ends, wherein one end is directly or indirectly connected to the base plate 5 and the other end is connected to the center pin 3. The connections between the supports 7 and the center pin 3 comprise each a holder 8 for the center pin 3.

[0129] The shown holders 8 are configured to support or carry a center pin 3 without locking it. Insofar, the shown holders 8 do not prevent all movement of the therewith connected center pin 3 in axial and/or radial direction, as a center pin 3 may for example be lifted upwards. In some examples it may be desirable to include holders 8 that restrict all movement of the center pin 3. Insofar, holders 8 may for example reach into the hollow center pin 3 and introduce a clamping force to said center pin 3.

[0130] The holders 8 shown in fig. 1b are U-shaped holders 8. Insofar, each holder 8 has two free ends protruding upwards and meeting in a half circle on the opposite side, e.g. a half ring. Insofar, the coil 2, i.e. the center pin 3, is positioned in between the two free ends of the holder 8 from above and then rested upon the described half ring of the holder 8. Such a holder 8 may be an easy to manufacture component to hold a center pin 3. Furthermore, loading of the container device 1 may be achieved by simply lowering the center pin 3 of the coil 2 in between the two free ends of a U-shaped holder 8.

[0131] Fig. 2 shows a rail 10 attached to the base plate 5. This rail 10 allows a sliding of the supports 7 in the axial direction of the center pin 3. Insofar, the distance of the supports 7 to each other becomes adjustable, such that the supports 7 can support center pins 3 of different lengths.

[0132] When adjusted to the length of the center pin 3 of the coil 2, the supports 7 may each be locked at a position of the rail 10 by a form-lock with a pin or screw. For this purpose, the rail 10 comprises multiple evenly spaced and horizontally aligned holes 11 through which the supports 7 may be fastened to the rail 10 with a pin or a screw. The supports 7 are also easily releasable from such a locked position in order to be repositioned and adjusted to the specific length of a different coil 2 or in particular its center pin 3.

[0133] Fig. 3 shows a base plate 5 comprising a guiding frame 12 for a cover 6. The guiding frame 12 protrudes upwards, i.e. in the direction of the cover 6, from the top of the base plate 5. The cover 6 is to be positioned outside of the guiding frame 12. By providing such a guiding frame 12, an easier montage and a better hold of the cover 6 on a base plate 5 may be achieved.

[0134] On every side of the guiding frame 12 is positioned a gasket 13 in form of a strip. This gasket 13 is positioned to secure a gas-tight connection between the guiding frame 12 and the cover 6 and between the base plate 5 and the cover 6. The gasket 13 is provided alongside the guiding frame 12 and also on the top of the base

plate 5. Such a gasket 13 may for example comprise rubber or fiber.

[0135] In fig. 4a and fig. 4b is shown a cover 6 that is partially transparent. Insofar, the cover 6 is made of metal, for example aluminum, and includes a window 14 made of glass or plastic and insofar a transparent area. Such a window 14 enables a look inside the container device 1 from the outside. Insofar, it becomes easily assessable whether the container device 1 is loaded with a coil 2 or not.

[0136] Furthermore, the cover 6 shown in fig. 4a and fig. 4b comprises handling means 15 for lifting and transporting of the cover 6 or even the container device 1. The handling means 15 are designed as handling bars and are comprised on the outside of the cover 6. In some examples, handling means in form of hooks for e.g. a crane may be desirable. Furthermore, in some examples stacking rails on top of a cover 6 may be desirable.

[0137] The base plate 5 shown in fig. 4a and fig. 4b also comprises multiple two-part fastening means 16 to fasten the cover 6 to the base plate 5. In so far, one part of each two-part fastening means 16 is provided on the side the base plate 5, wherein the other part of each two-part fastening means 16 is provided on the cover 6. The two parts of each two-part fastening means 16 interact such that the connection between the base plate 5 and the cover 6 can be tightened in a gas-tight manner.

[0138] The two-part fastening means 16 are designed as a spring lock with a spring clip. By providing multiple two-part fastening means 16 designed as spring locks, a clamping force can be applied on the cover 6 that clamps the cover 6 onto the base plate 5.

[0139] In fig. 5, a container device 1 is shown without a cover 6. The coil 2 and the center pin 3 are not yet supported by supports 7. Insofar, fig. 5 shows a stage of an exemplary loading process of a container device 1.

[0140] The center pin 3 of the coil 2 is supported by two suspended hangers of a piece of manufacturing equipment. The hangers 17 are suspended from above (or from lateral sides of) the coil 2 and the base plate 5. Only a segment of the hangers 17 is shown in fig. 5.

[0141] The hangers 17 may be part of a piece of manufacturing equipment within a roll-to-roll manufacturing process. The piece of manufacturing equipment may be located in a dry room, e.g. in a "mini-environment". For example, the hangers 17 may be part of a slitting machine where a mother coil is slit into multiple daughter coils. The shown coil 2 may thus for example be a daughter coil of said mother coil, that has been completely wrapped (i.e. wound up on the center pin of the coil) after the slitting process and may now be transported to a different mini-environment.

[0142] The base plate 5 is positioned beneath the coil 2, wherein the supports 7 and in particular the holders 8 are aligned with the center pin 3. When the loading process of container device 1 commences, the base plate 5 and thus the supports 7 may be raised until a contact between the holders 8 and the center pin 3 is

established. After the contact is established, the raising is continued until the supports 8 "pick up" or lift the center pin 3 and therewith the coil 2. When the coil 2 is lifted, the hangers 17 may be removed (i.e. may be released from the center pin) or the base plate 5 is moved in such a manner, that the center pin 3 is moved away from the hangers 17.

[0143] Such a raising of the base plate 5 may for example be carried out with a fork lift. It is also possible that the supports 7 may be designed telescopic and can thus extend in their length to pick up the center pin 3.

[0144] Afterwards, a cover 6 may be positioned onto the base plate 5 and fastened to said base plate 5 in a gas-tight manner and the closed container device may transported in a safe manner out of the dry room.

[0145] Throughout the description, including the claims, the term "comprising a" should be understood as being synonymous with "comprising at least one" unless otherwise stated. In addition, any range outlined in the description, including the claims should be understood as including its end value(s) unless otherwise stated. Specific values for described elements should be understood to be within accepted manufacturing or industry tolerances known to one of skill in the art, and any use of the terms "substantially" and/or "approximately" and/or "generally" should be understood to mean falling within such accepted tolerances.

[0146] Although the present disclosure herein has been described regarding particular examples, it is to be understood that these examples are merely illustrative of the principles and applications of the present disclosure.

[0147] It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims.

REFERENCES

[0148]

1. Container device
2. Coil
3. Center pin
4. Foil
5. Base plate
6. Cover
7. Supports
8. Holder
9. Substructure
10. Rail
11. Holes
12. Guiding frame
13. Gasket
14. Window
15. Handling means
16. two-part fastening means
17. Hangers

Claims

1. A container device (1) for transporting a coil (2), the coil (2) comprising a center pin (3) on which a moisture-sensitive foil (4) is wound, comprising:

a base plate (5) and a cover (6) configured to be removably positioned on the base plate (5), such that the base plate (5) and the cover (6) enclose the coil (2) in a gas-tight manner, and supports (7) projecting upwards from the base plate (5) into the container and configured to support the center pin (3) of the coil (2).

2. The container device (1) of claim 1, wherein

the cover (6) encloses the coil (2) on the top and on lateral sides, and/or
the cover (6) has only one opening which is designed to fit together with the base plate (5), so that the coil (2) is completely enclosed.

3. The container device (1) according to any one of the preceding claims, wherein

the supports (7) are arranged inside the cover (6), when the cover (6) is positioned on the base plate (5), and/or
each support (7) has a recessed or U-shaped holder (8) configured to hold the center pin (3).

4. The container device (1) according to any one of the preceding claims, wherein the distance of the supports (7) to each other is adjustable, such that the supports (7) can support center pins (3) of different lengths.

5. The container device (1) according to any one of the preceding claims, wherein the container device (1) is a passive device without energy, gas or air supply, such as an internal or external power, gas or air source.

6. The container device (1) according to any one of the preceding claims, wherein the base plate (5) has a substructure (9), such as feet, configured such that a lifting device can pass underneath and lift the base plate (5).

7. The container device (1) according to any one of the preceding claims, further comprising
a sensor configured to detect moisture in the atmosphere of the container.

8. The container device (1) according to any one of the preceding claims, wherein the moisture-sensitive foil

(4) is an electrode foil (4), such as a cathode foil (4).

9. A system for winding and transporting a coil (2), comprising:

a winding device configured to wind a center pin (3) of the coil (2) with a moisture-sensitive foil (4), the container device (1) according to any one of the preceding claims,
a lifting device configured to lift the base plate (5), and optionally
a closing device configured to position the cover (6) on the base plate (5) in a gas-tight manner.

10. The system according to the preceding system claim, wherein
the system further comprises a dry room in which is arranged: the winding device,
the container device (1), the lifting device, and the optional closing device.

11. The system according to the preceding system claim 9 or 10, wherein
wherein the system is configured such that, when the moisture-sensitive foil (4) is wound on the center pin (3):

the lifting device positions the base plate (5) without the cover (6) below the coil (2) and lifts the base plate (5) such that the supports (7) engage with and support the center pin (3) of the coil (2) and at the same time the center pin (3) disengages from the winding device,
the lifting device removes the base plate (5) and the supported coil (2) from the winding device, optionally the closing device positions the cover (6) on the base plate (5), such that the base plate (5) and the cover (6) enclose the coil (2) in a gas-tight manner, and
optionally the lifting device transports the container device (1) out of the dry room.

12. A method of inserting a coil (2) into a container device (1), the coil (2) comprising a center pin (3) on which a moisture-sensitive foil (4) is wound, the container device (1) comprising a base plate (5), a cover (6) configured to be removably positioned on the base plate (5) and supports (7) projecting upwards from the base plate (5) into the container, the method comprising:

positioning the base plate (5) without the cover (6) below the coil (2),
lifting the base plate (5) such that the supports (7) engage with and support the center pin (3) of the coil (2) and at the same time the center pin (3) disengages from a winding device,
removing the base plate (5) and the winding

device from each other, and
positioning the cover (6) on the base plate (5),
such that the base plate (5) and the cover (6)
enclose the coil (2) in a gas-tight manner.

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- 13.** The method according to the preceding method claim, further comprising:
transporting the container device (1) to another location, such as to another dry room.

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- 14.** The method according to the method claim 12 or 13, further comprising before positioning the base plate (5):
winding the moisture-sensitive foil (4) on the center pin (3) by means of the winding device.

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- 15.** The method according to any one of the method claims 12 to 14, further comprising before winding the moisture-sensitive foil (4):
inserting the container device (1) into the dry room with the cover (6) being removed from the base plate (5).

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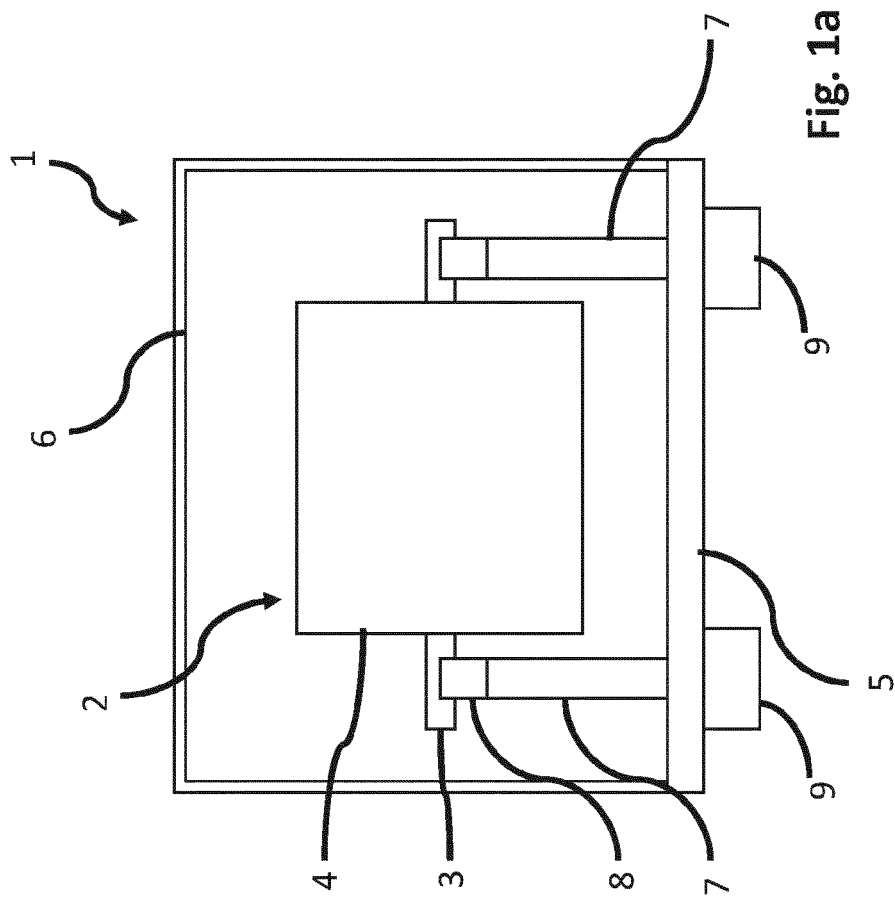
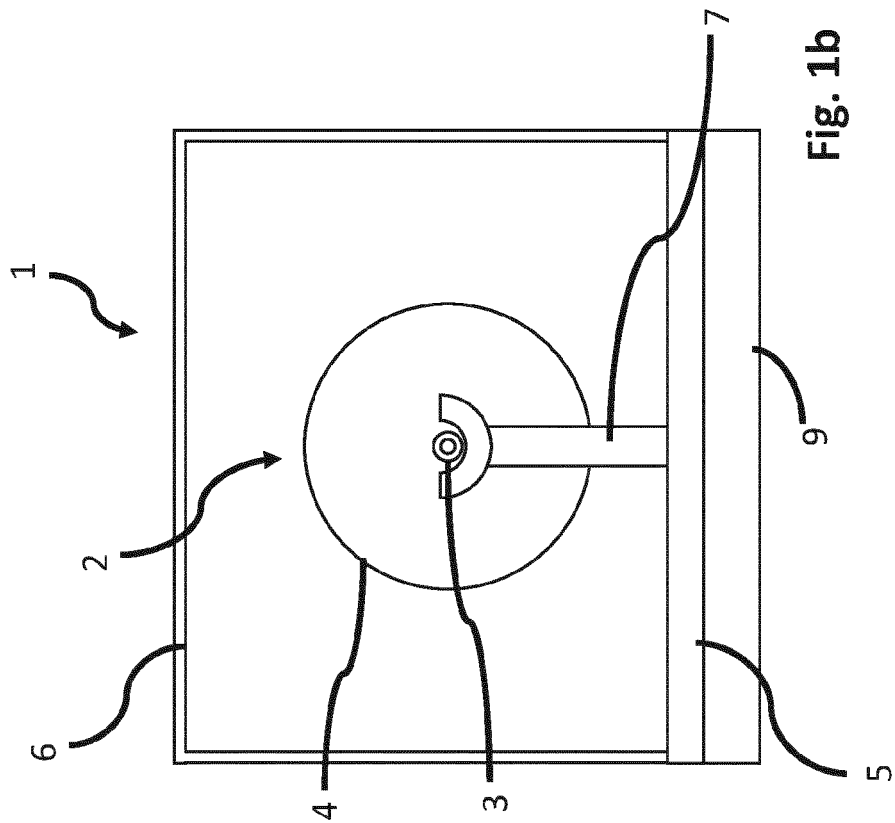
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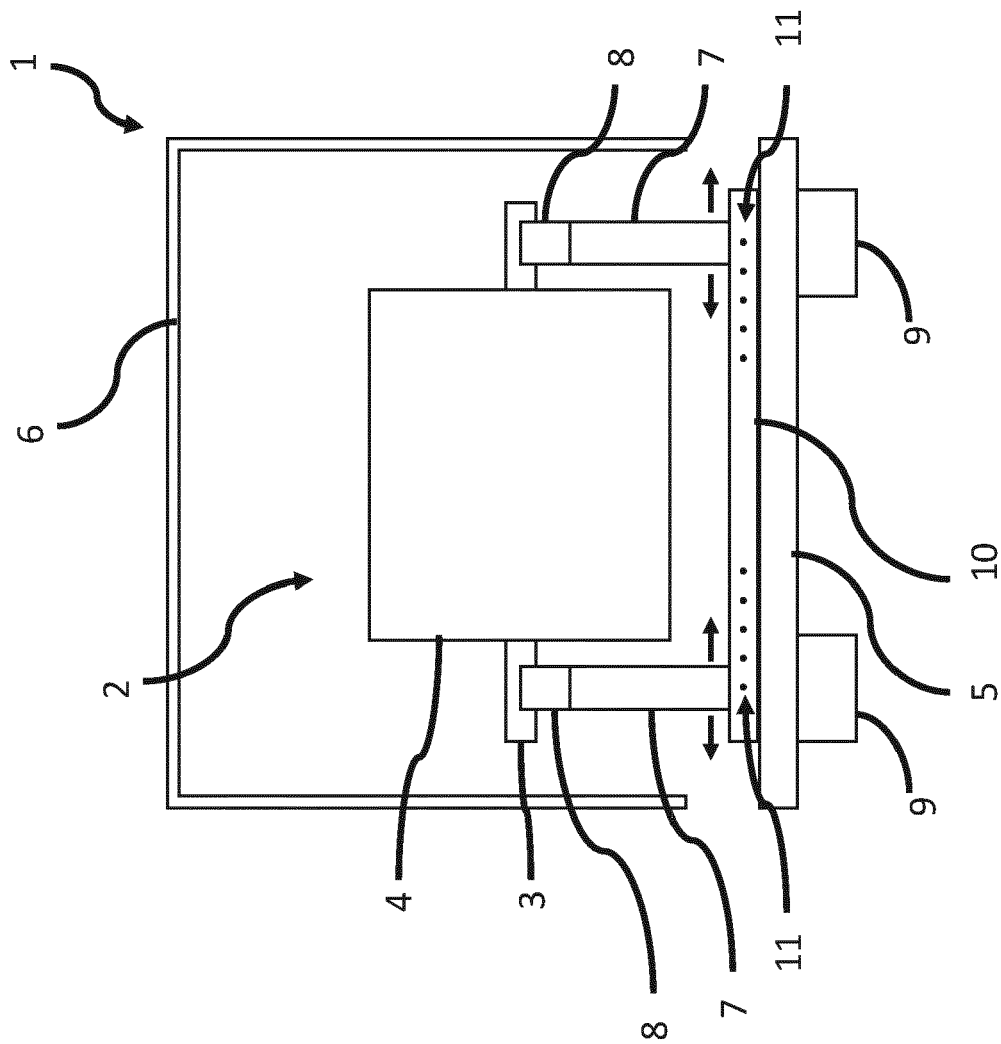


Fig. 2

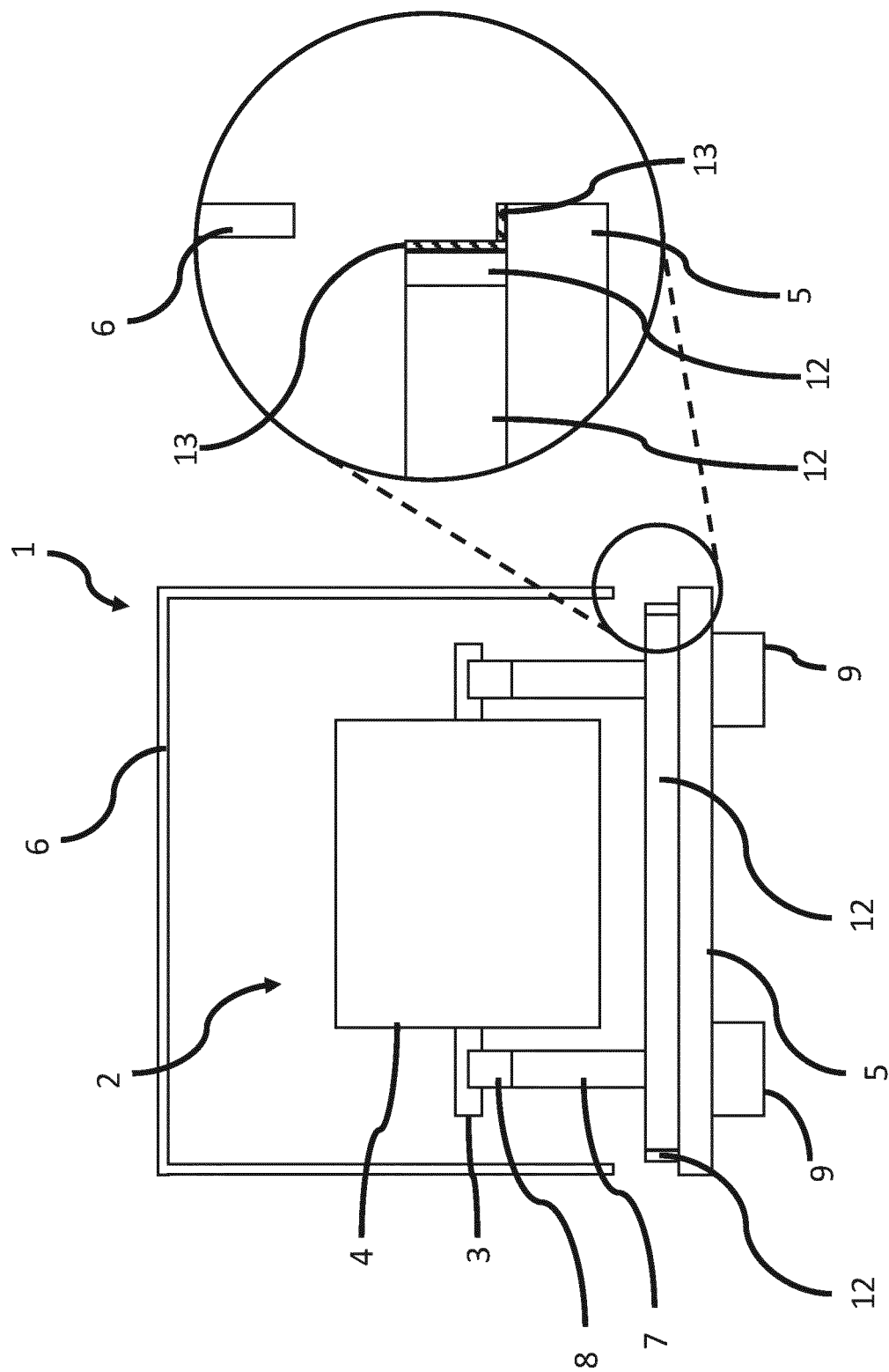
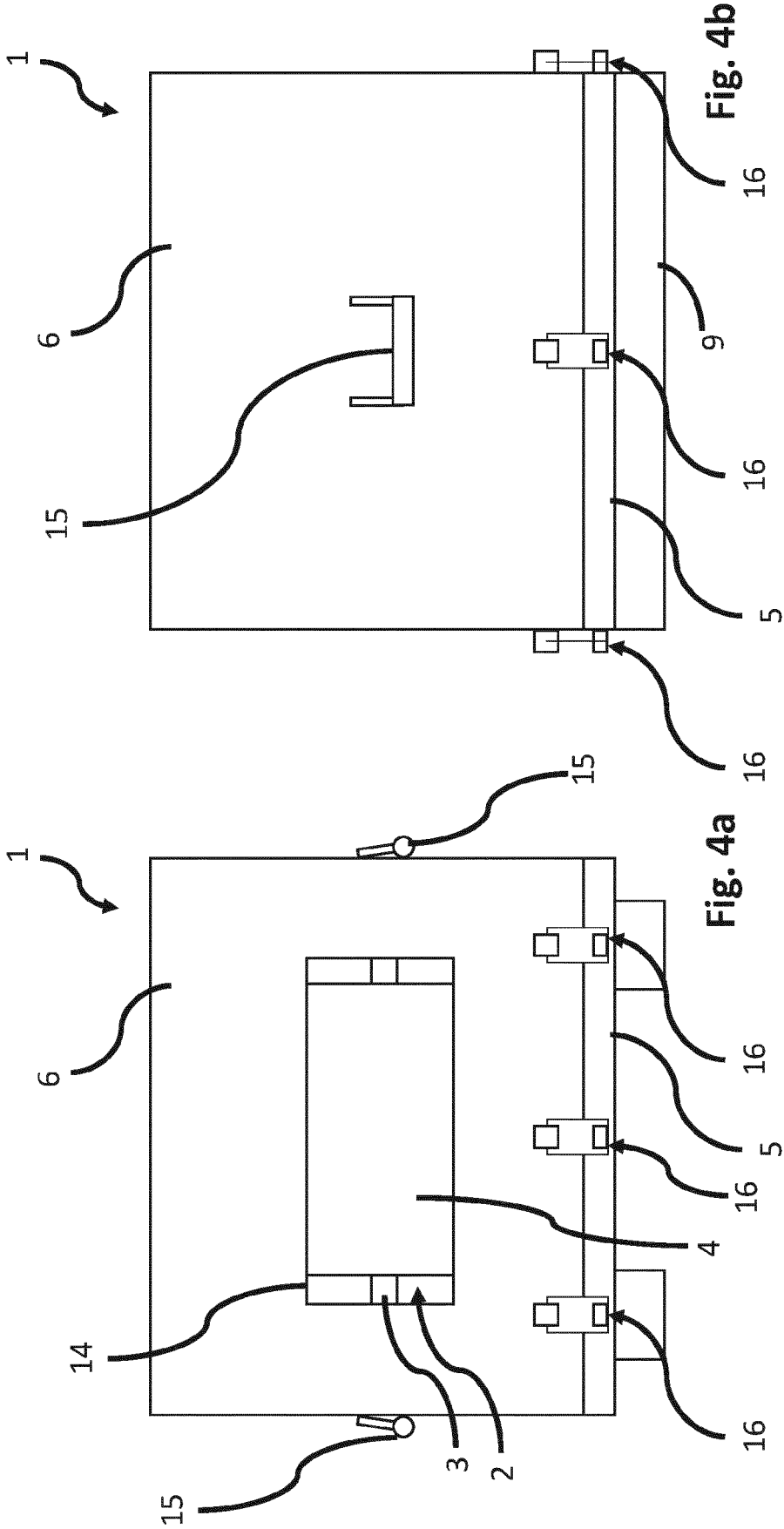


Fig. 3



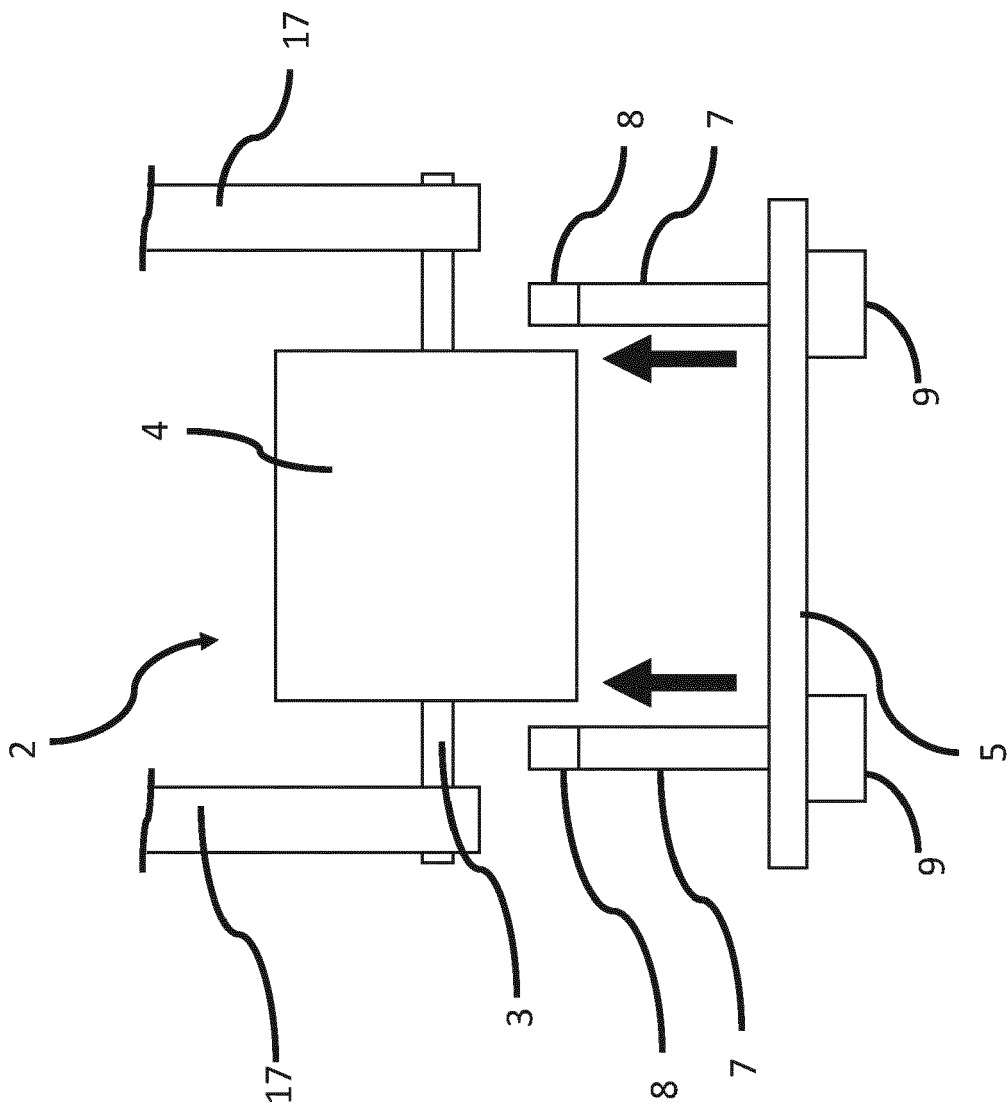


Fig. 5



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Application Number

EP 23 21 6882

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Place of search		Date of completion of the search	Examiner
Munich		17 May 2024	Fitterer, Johann
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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