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(54) **COATING APPLICATION DEVICE AND METHOD OF USING A COATING APPLICATION DEVICE**

(57) Assembly for forming a coating application device configured to spray a coating material onto a surface to be sprayed (S) with a coating material, said assembly comprising: a base part configured to cause or assist displacements of the coating application device with respect to a surface to be sprayed (S), a spraying unit con-

figured to release coating spray; and a protecting unit configured to be fixedly or removably connected with said base part and to protect coating spray against wind, wherein the protecting unit is at least partially dome-shaped.

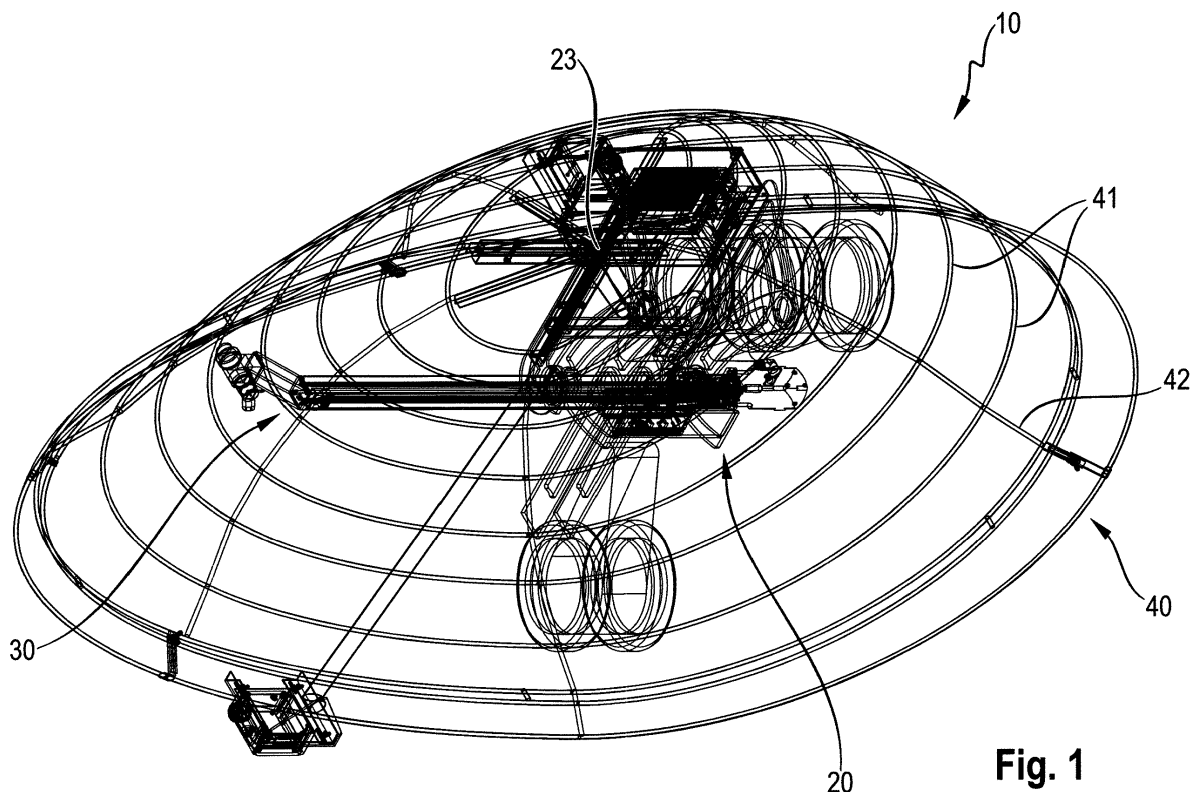


Fig. 1

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Description

[0001] In the field of petrochemical industry, storage tanks are used widely for storing fluids, i.e. liquids and/or gases. Often it is of vital importance to ensure with a high degree of accuracy that no fluid stored in such a tank escapes into the surrounding, e.g. spills or evaporates. This requirement puts substantial demands on the quality of the outer walls surrounding a storage tank. Naturally, the outer wall surfaces are prone to wear. The outer walls are further in need of special attention given that storage tanks are frequently located in places which expose them to weather hazards such as strong wind conditions. To protect the outer walls as much as possible, they are often coated with protective coating layers comprising e.g. paint(s) or lacquer(s).

[0002] Both during the construction of new storage tanks and during the maintenance of a storage tank already in use, a certain amount of effort is required to provide an outer wall of a storage tank with a coating layer for the first time, or to replace the old coating layer with a new one. While a worker can of course apply a coating layer himself, driverless, mobile coating application vehicles have been developed, which can be used to spray a coating material onto the wall of such a storage tank, merely requiring an operator positioned at a distance from the storage tank. This saves considerable man power during construction and maintenance of storage tanks.

[0003] A known type of coating application vehicle is provided with a spraying unit including a nozzle configured to release coating spray, and with wheels, by virtue of which the vehicle contacts a surface to be coated and on which the vehicle is displaced on the surface being coated during the coating procedure. Normally, storage tanks have cylindrical upwardly directed side walls, and such a coating application vehicle is thus oriented in a substantially vertical position, the wheels contacting the vertically extended side walls, while spraying coating material on to the wall. In order to stabilize the vehicle in a contact position with such a side wall, known vehicles are provided with a magnetized unit, which is attracted by the force of an external magnet, and such a magnet is located inside of a storage tank, being coated. The magnet can then be used to easily guide the vehicle across the surface to be coated, in order to distribute the coating material over the entire wall to be coated.

[0004] WO 2012/038806 A2 discloses an apparatus for spraying a coating material onto a hull of a ship. The apparatus comprises a first vehicle configured to be positioned next to an object to be sprayed and provided with a crane-like structure including a spraying device located on its tip end, the spraying device being configured to be brought into close proximity with a hull of a ship, to spray a coating material onto a surface to be sprayed. The spraying device is provided with a suction means configured to suck-in dispersed paint particles, so as to prevent residues of paint from escaping into the

surrounding. The apparatus further comprises a second vehicle configured to be positioned next to an object to be sprayed, the second vehicle comprising a suction unit which is connected to the suction means through a pipe. However, the air flow currents induced by the suction means may distort the coating pattern and, hence, lead to inhomogeneities in a coating layer. As the two vehicles of the apparatus of WO 2012/038806 A2 require a substantial amount of space next to an object being painted, and as they need to be moved around frequently during a spraying process, the use of the apparatus of WO 2012/038806 A2 may not be efficient, and even impossible, when an insufficient amount of space is available. Moreover, the structure of the apparatus with the vehicles is complicated and expensive.

[0005] Also WO 01/034309 A2 discloses an apparatus for spraying an object such as a hull of a ship. The apparatus comprises a vehicle configured to be positioned next to an object to be sprayed and a crane-like structure comprising a spraying device at its tip end. In addition, the apparatus comprises a suction means driven by a corresponding suction pump, the suction means being configured to suck in dispersed paint particles. The drawbacks of the apparatus of 01/034309 A2 are analogous to those of the apparatus disclosed in WO 2012/038806 A2.

[0006] FR 2 774 313 A1 discloses a coating application apparatus which is configured to move autonomously on an object to be sprayed with a coating layer, without there being any connection to a vehicle standing on the ground next to the object being painted. The coating application apparatus comprises an inner, an outer, and an intermediate cap, which are all connected to each other and together surround an ejection nozzle and in this way shield off paint particles from being dispersed into the surrounding. The intermediate cap is of an elastic and foldable/unfoldable nature, so that it can ensure a continuous connection between the inner and outer cap, even when they are moved relative to each other, for example, when the distance between the spraying nozzle and an object to be sprayed is varied. However, the structure with the three caps is complicated and leads to an increased size. Moreover, the caps may receive large amounts of winds, so that a wind gust may displace the apparatus or at least temporarily lead to an increased gap size of a gap between an object being sprayed and the caps, so that dispersed paint particles may leak out into the surrounding. In turn, this may also lead to variations in the thickness of a coating being applied onto an object being sprayed.

[0007] While the known coating application devices have proved to be extremely useful, there appears to be room for improvement, as the coating layers on outer walls of storage tanks, which were applied with known coating application devices, may show undesirable variations such as inhomogeneity, e.g. varying thicknesses.

[0008] In view of the afore-mentioned problems, it is an object of the present invention to provide an assembly for forming a coating application device which is suited

to provide a surface to be sprayed with a coating layer with higher precision, e.g. with a higher homogeneity. Additionally, it is an object of the present invention to provide a method of use of such a coating application device, as well as a protecting unit configured to be used with such a coating application device.

Description of the invention

[0009] An assembly for forming a coating application device according to the present invention is defined by the combination of features of claim 1. Dependent claims pertain to preferred embodiments. A method according to the present invention is defined by the combination of features of claim 17. A protecting unit according to the present invention is defined by the combination of features of claim 18.

[0010] The term 'assembly for forming a coating application device' refers to a coating application device either in disassembled or in assembled condition. For ease of description, reference will, however, be made in the following simply to a 'coating application device' instead of always referring to the assembly. Often, reference will be made to the assembled condition of the coating application device, in order to explain how it functions. However, all of the following references to preferred embodiments of a coating application device are to be understood as descriptions of preferred embodiments of assemblies for forming a coating application device which corresponds to the coating application device being described.

[0011] The invention provides a coating application device configured to spray a coating material onto a surface to be sprayed with a coating material. The device comprises a base part configured to cause or assist displacements of the coating application device with respect to a surface to be sprayed, a spraying unit configured to release coating spray, and a protecting unit fixedly or removably connected with said base part, wherein said protecting unit is configured to protect coating spray against wind. The coating application device is advantageous, as it allows the prevention of (at least a part of the) wind from reaching coating spray. Thus, coating spray is less prone to be carried off into the surrounding. This also means that the device can avoid pollution of the surrounding, by avoiding or at least reducing the amount of coating spray being released into the surrounding. Additionally, coating material is provided on to a surface to be coated more precisely, as less distortion by virtue of less or no coating spray being led away from its intended position, before having reached the surface to be sprayed. Thus, one can spray a surface more evenly/homogeneously than when using a device according to the prior art.

[0012] In some embodiments, the base part thus comprises all of the structural components needed to cause the displacements of the device and is thus self-autonomous in this respect. In other embodiments, the base part interacts with one or several external components.

Said interaction may, for example, be mediated by an electric and/or an electric force, by virtue e.g. of an external magnet attracting a part of the device. Moreover, the invention encompasses both embodiments wherein the displacements with regard to a surface to be sprayed are displacements on the surface (e.g. when the device has wheels or when the device is located on rails provided on the surface), and embodiments wherein the device e.g. hovers in front of the surface and is displaced while flying, without contacting the surface.

[0013] The device is not limited with regard to what kind of surfaces can be sprayed. While one embodiment of the device might be designed to spray coating material onto a flat surface, another embodiment might be designed for a curved surface, while a third embodiment is configured to spray onto either of them, or onto a surface with dynamically varying curvature, e.g. comprising flat and curved zones, such as surfaces of a building or a ship. In any case, a coating application device according to the present invention is particularly suited to spray coating material onto an outer surface, e.g. a top or a side wall surface, of a storage tank.

[0014] The protecting unit is fixedly or removably connected with said base part, directly or indirectly. The protecting unit may thus for instance be directly connected to the spraying unit which may itself be connected to the base unit. In that way, the protecting unit may be connected with the base part. The purpose of being connected with the base is that the protecting unit will accordingly displace together with the base.

[0015] The protecting unit is merely required to protect coating spray against wind, but is not particularly limited with regard to shape and design etc. For example, the protecting unit can be designed such that it is a partial cover of the base part, partially covering said base part, when the device is positioned on a surface to be sprayed. In this case, the protecting unit may also be at least a partial cover of at least a part of the spraying unit with respect to a direction from which wind is approaching or is to be expected. In some embodiments, the protecting unit may shield-off coating spray from wind coming from a certain direction or directions, whereas it may protect coating spray from wind coming from a whole set or all directions, in other embodiments. It is preferable, if the protecting unit is specifically designed to protect coating spray, if present between e.g. a spraying nozzle from which it is released and the surface for which it is destined, from wind. The protection against the wind may be full or partial, depending on the embodiment.

[0016] The protecting unit is at least partially dome-shaped. The dome-shape can e.g. resemble a part of the surface of a ball, of an ellipsoid or an egg. The dome-shape may refer to the general contour of the protecting part, so that a dome-shape also refers to the situation in which components or parts stick out of the general contour. In addition, the dome-shape may be symmetric or it may be anti-symmetric with respect to one or several sections. As an example, the dome-shape may merely

be symmetric with respect to a single sectional surface, e.g. when it resembles a part of a surface of an egg or an ellipsoid. Preferably, the general contour of the protecting unit resembles the general contour of a storm umbrella, having an anti-symmetric general appearance. However, the contour of the protecting unit may be smoother than that of a storm umbrella. The dome-shape is advantageous from a technical point of view, as it promotes a high resistivity of the device against wind and helps to avoid the entire coating application device being displaced, damaged or even blown off from a surface to be sprayed, due to extreme weather conditions such as strong gusts of wind etc.

[0017] The dome-shape reduces the wind resistance, so that the likelihood of wind gusts displacing the coating application device or increasing the size of a gap between a surface to be sprayed and the protecting unit decreases. In particular, due to the dome-shape, especially wind gusts which are oriented substantially in parallel to a surface being sprayed do not hit the protecting unit at an almost right angle, but at smaller angles. The dome-shape therefore decreases the strength of forces acting on it in directions substantially parallel to a surface being sprayed. The dome-shape further promotes the wind gusts being lead along the curved form of a dome-shape. Hence, the coating application device with the dome-shaped protecting unit can be more stably and precisely maintained in a spraying position. The coating application device is thus especially effective for use at locations which may be exposed to winds with high speeds. The increased stability also implies that a higher degrees of homogeneity (e.g. with respect to thickness) of a coating layer on an object to be sprayed can be ensured. In addition, the dome-shaped protecting unit is of a simple structure as it does not require any additional elements such as a suction means in order to protect coating spray against wind.

[0018] According to a preferred embodiment of the present invention, the protecting unit comprises at least one shielding part with an interior side facing at least a part of the spraying unit and an exterior side facing away from said part of the spraying unit, wherein the shielding part is configured to shield off coating spray, when present between said part of the spraying unit and the surface to be sprayed. The shape of said shielding part is not particularly limited, as the presence of a shielding part of any shape may provide the desired shielding effect for the coating spray. However, the shielding part may typically at least partially be shaped as a surface on the interior and/or the exterior side. This preferred embodiment is especially advantageous, as the shielding effect of the shielding part for coating spray present between said part of the spraying unit and the surface to be sprayed implies that wind cannot reach coating spray and cannot start re-directing coating spray, when present in a region where it is being released from the spraying unit and directed at the surface to be sprayed. According to this embodiment, the coating spray is protected during

a crucial period of time, namely after its release from the spraying unit and before reaching the surface to be sprayed.

[0019] According to another preferred embodiment of the present invention, the base part comprises at least one contact point for contacting a surface to be sprayed, and the protecting unit preferably comprises a shielding edge portion which is positioned or positionable in a predetermined location with respect to the at least one contact point. This preferable arrangement allows the positioning of the shielding edge portion with respect to said at least one contact point, such that merely a small gap is left between the shielding edge portion and the surface to be sprayed, yielding an effective protection of coating spray against wind, at least until shortly before the coating spray contacts the surface to be sprayed. Such a gap between the surface to be sprayed and the shielding edge portion may be constant along the shielding edge portion or it may vary, depending e.g. on the shape of the surface to be sprayed and the shape of the protecting unit and of the shielding edge portion, in particular. Preferably, the protecting unit comprises a shielding part with at least one surface, an edge of which is said shielding edge portion. Said shielding part shields a region extending from where coating spray is released to said shielding edge portion from wind. The protecting unit as a whole thus protects coating spray almost throughout its entire lifetime, from when it is released until just before it reaches the surface to be sprayed.

[0020] Said shielding edge portion preferably at least partially surrounds the base part. This provides an especially effective protection from the wind. It is even more preferable, that the shielding edge portion fully surrounds the base part. With this arrangement, the shielding edge portion may be positioned or may be positionable with respect to the at least one contact point, such that merely a gap is left between the surface to be sprayed and said shielding edge portion, said gap extending around the entire base part, as the shielding edge portion surrounds the base part. The invention both comprises embodiments, wherein the shielding edge portion takes on a fixed position and is thus positioned in said fixed position with respect to the at least one contact point, and embodiments, wherein the shielding edge portion can be displaced with regard to said at least one contact point and is thus positionable at a predetermined position. The embodiments wherein the shielding edge portion is positioned in the fixed position are especially advantageous, as they are simpler and cheaper to manufacture. Moreover, they may be especially robust and stable. The embodiments wherein the shielding edge portion is positionable are especially advantageous, as they may allow a precise adaption of said position depending on the surface to be sprayed, e.g. the curvature of said surface etc.

[0021] Preferably, the base part comprises at least three contact points, including said at least one contact point mentioned previously. The at least three contact

points define a plane, which may be flat or (especially if there are more than three contact points) be curved. Such a curved plane may for example be a plane comprising said at least three contact points with minimal curvature amongst all planes comprising all of the contact points. The above-mentioned shielding edge portion is then positioned or positionable at a predetermined distance with respect to said plane.

[0022] According to one embodiment, the base part comprises three or six wheels, and each wheel comprises a contact point, at which the wheels are intended to contact a surface to be sprayed. In this situation, the contact points may define a flat plane, whereas the surface to be sprayed may nevertheless be curved, as is often the case for side walls of cylindrically shaped storage tanks. The predetermined distance between the shielding edge portion and said plane may be constant along the entire shielding edge portion or it may vary. As the surface to be sprayed may be curved, it may also occur that the shielding edge portion intersects said plane, and, possibly, that a part of the shielding edge portion is located closer to the surface to be sprayed than to the plane defined by the contact points. Put differently, the shielding edge portion may be designed such that when the coating application device is positioned on a surface to be sprayed, that the shielding edge portion takes on a certain (constant or varying) distance with respect to said surface to be sprayed and thus intersects the plane defined by the contact points.

[0023] According to a another embodiment of the invention, the protecting unit is shaped, at least at a part of the shielding edge portion and/or a part adjacent to the shielding edge portion, so as to promote wind being guided away from coating spray. The shape may for example be such that wind is guided towards the exterior side of the protecting part or even away from the protecting part. Such an arrangement is advantageous, as it prevents wind from being easily guided towards the interior side of the protecting part. When the coating application device comprises a shielding edge portion, this preferable embodiment is especially advantageous, as it does not promote wind from passing through a gap formed between the shielding edge portion and a surface to be sprayed.

[0024] It is further also preferable that the protecting unit comprises at least one shielding surface which is closed in itself or comprises at least one hole. When the shielding surface is closed or merely comprises one or several holes, it shields off coating spray from the wind especially efficiently, as the wind cannot enter an interior side of the protecting unit, except for the hole (s) and/or a gap formed between the protecting unit and the surface to be sprayed, e.g. between the surface to be sprayed and a shielding edge portion. Thus, it is especially advantageous if the shielding surface is closed and when the coating application device comprises the shielding edge portion positioned or positionable with respect to the above-mentioned contact points, as the wind cannot

enter the region where coating spray is present, except for the small gap left between the shielding edge portion and the surface to be sprayed.

[0025] Said shielding surface is preferably configured to be removable. This is advantageous, as the shielding surface can then be replaced, when necessary, without having to replace any other components of the coating application device. For example, when the shielding surface has collected a certain amount of coating spray on its' inside surface and is thus 'contaminated', it can be replaced, and the replaced shielding surface is again ready to collect coating spray. It is therefore also preferable, if the shielding surface is made from a disposable material.

[0026] According to another embodiment of the present invention, the protecting unit further comprises a frame with a plurality of support bars. The frame is configured to absorb reaction forces and/or stress resulting from air pressure differences between the air present between the protecting unit and a surface to be sprayed and a region outside of the protecting unit, and/or wind forces acting on the coating application device. Preferably, said frame has a mechanical strength of 100N/mm² or higher, even more preferably of 130N/mm², and even more preferably of 150N/mm². The plurality of support bars may comprise one or several first support bars extending in the surface substantially parallel to a shielding edge portion, and said first bars may be connected by second support bars. The above-mentioned shielding surface may e.g. be fixedly or removably mounted to the frame. A removable shielding surface is especially advantageous, as this simplifies the process of removing and replacing a shielding surface with a new shielding surface, as the frame may stay in place during the maintenance or replacement of a shielding surface.

[0027] The protecting unit of a coating application device according to a preferred embodiment is dimensioned such that it encapsulates, together with a surface to be sprayed, between 30% and 99,9% of the base part. It is more preferable, if it encapsulates between 60% and 99%, and even more preferable if it encapsulates between 90% and 98% or even between 94% and 96% of the base part. When a coating application device according to the present invention is positioned on a surface to be sprayed, the protecting unit may resemble a shell surrounding most of the base part, up to a gap between the surface and the shielding edge portion. Moreover, the shielding edge portion may be curved. This is especially advantageous as the curvature may be adapted to the curvature of the surface to be sprayed. Thus, depending on the radius of curvature of said cylindrical side wall, the radius of curvature of the shielding edge portion of the protecting unit may be specifically adapted. For example, a storage tank may have a diameter of approximately 60m, which allows the selection an appropriate radius of curvature for the shielding edge portion of a protecting unit of a device which is intended for the use on such a storage tank, in order to realize the above-

mentioned degree(s) of encapsulation of the base part by virtue of the protecting unit and the surface to be sprayed and a small gap between the shielding edge portion and a surface to be sprayed along the entire shielding edge portion.

[0028] The spraying unit of a coating application device according to a preferred embodiment comprises at least one spraying nozzle. The spraying unit may be configured to work according to a so-called HVLP (High Volume Low Pressure) spraying method, an airless spraying method or an electrostatic spraying method. However, the spraying unit is preferably configured to work according to an airmix spraying method, wherein the coating material is pressurized with a pump unit and wherein air is additionally used to form the coating picture. The pressure applied to the coating material is lower than when using an airless spraying method, and an advantage of using the airmix method lies in the lower flow rate of the coating material particles, which means that less coating spray is generated, making it less prone to distortion e.g. due to wind effects.

[0029] Said at least one spraying nozzle is preferably located in a flatter part of the device, in the sense that the spraying unit is preferably located in a region covered by a flatter part of the protecting unit, wherein flat refers to the projection height of the protecting unit with respect to a surface to be sprayed, when the coating application device is arranged on said surface. The general contour of the protecting unit may resemble the anti-symmetric shape of a shield part of a storm umbrella, and the spraying nozzle is then preferably located below an elongated and flatter part of the protecting unit. However, the spraying nozzle may be located somewhere else in other embodiments, depending on the size of the internal coating application device and the desired distance between the spraying nozzle and a surface to be sprayed. An advantage associated with the above-mentioned preferred location of the spraying nozzle with regard to the anti-symmetric shape of the protecting unit lies in being able to reduce the entire size of the protecting unit, i.e. making it e.g. less projecting with regard to a surface to be sprayed, reducing the exposure to wind effects etc. In addition, the orientation of an asymmetric protecting unit with regard to the spraying unit may be fixed or actively adapted (in embodiments comprising a corresponding drive mechanism) such that the wind resistance is small in a direction from which wind is approaching. The spraying unit may also may be oriented with regard to the protecting unit, such that coating spray is released at a spot or a zone on the surface to be sprayed, which will not be subsequently touched by any part of the coating application device during subsequent movement(s), so that the coating layer applied to the surface is not distorted by virtue of the coating application device touching it, at least not touched before said coating layer has dried to a sufficient extent.

[0030] Preferably, the protecting unit is configured to be at least partially collapsible. One might regard this as

similar to a collapsible roof of a convertible. The collapsibility of the protecting unit is advantageous, as the collapsed state may be convenient for maintenance of parts of the coating application device which are not (or at least not easily) accessible, when the protecting unit is in the non-collapsed state. The collapsed state may also be beneficial during storage of the coating application device, because the device may take up less space, and the protecting unit may be less prone to contamination with dust or other materials. Moreover, the collapsed state may also be advantageous when the device is used to spray coating spray onto a region of a surface to be sprayed where there is little space so that the protecting unit would be in the way in the non-collapsed state.

[0031] According to another preferred embodiment, the base part comprises at least one wheel. In particular, the present invention comprises embodiments wherein the base part comprises three or even six wheels, wherein the wheels may also be provided in pairs on the same axis. Preferably, the above-mentioned at least one contact point for contacting a surface to be sprayed is then provided on said at least one wheel. For example, when the base part comprises six wheels, each of the six wheels may comprise a contact point, where the base part will contact a surface to be sprayed, when the coating application device is in use.

[0032] It is also preferable, if at least a part of the base part of the coating application device is magnetized or magnetizable. For example, one or several wheels or a constituent attached to the frame or a part of or the whole frame itself may be magnetized or magnetizable. The magnetized or magnetizable component can be attracted by virtue of an external magnet placed e.g. on the other side of a surface to be sprayed. This way, the base part of the coating application device is configured to assist displacements of the coating application device with respect to a surface to be sprayed. The displacements are realized by virtue of the interaction of the external magnet and the magnetized or magnetizable part of the base part. When coating a side wall of a storage tank, the external magnet may be located inside of the storage tank, i.e. on the other side of the wall to be sprayed, and said external magnet may be controlled and/or spatially displaced, in turn resulting in displacements of the coating application device with respect to the surface to be sprayed.

[0033] According to another preferred embodiment, the coating application device further comprises a coating material supply unit for supplying coating material to the spraying unit. Said coating material supply unit may be a coating medium pump, used to pump a coating material towards a spraying unit. Preferably, said coating material supply unit and the spraying unit are designed to perform an airmix spraying method.

[0034] The coating application device may further comprise an adjustment mechanism for adjusting the position of at least a part of the protecting unit. The part of the protecting unit which is adjustable may comprise a

shielding edge portion, as described above. The width of a gap between said shielding edge portion and the surface to be sprayed is thus adjustable using the adjustment mechanism. This is advantageous as such an adaption of the width of a gap allows tailoring the configuration of the coating application device to a certain surface to be sprayed. For example, the shielding edge portion may be repositioned, reacting to a varying curvature of a surface to be sprayed. When an outer wall of a ship is being sprayed, a dynamic adjustment of the position of the shielding edge portion may be preferable (especially when spraying coating material on a bow or a stern of a ship). Moreover, the shielding edge portion may also be positioned differently for the use of the coating application device on different surfaces to be sprayed. When spraying coating material on outer walls of storage tanks, the shielding edge portion may therefore, for example, be positioned differently for use on storage tanks with different sizes and comprising side walls with different radiuses of curvature.

[0035] Preferably, the coating application device comprises at least one sensor means configured to acquire data on a distance between a part of the device and a surface to be sprayed and/or the thickness of a coating layer apply to a surface to be sprayed. The presence of such a sensor means is advantageous, as the acquired data can be used to control (manually or using a control means) other components of the coating application device. For example, said data can be used to control the above-mentioned adjustment means or at least a part of the spraying unit.

[0036] The coating application device may also comprise a controller configured to control the above-mentioned adjustment member using said data. This is especially advantageous, as the position of at least a part of the protecting unit can then be adjusted depending on the distance between a part of the device and a surface being sprayed and/or the thickness of a coating layer. In other words, a dynamic feedback control e.g. of the width of the gap between a part of the protecting unit such as a shielding portion of the protecting unit and the surface to be sprayed is made possible, e.g. depending on the curvature of the surface to be sprayed. In addition to or instead of said controller, the coating application device may also comprise a sending means configured to send said acquired data to an external controller, wherein the external controller may perform a feed-back control by sending back a control signal to the coating application device. The present invention however also encompasses embodiments, wherein no adjustment member is provided, and wherein the data acquired by said at least one sensor means is e.g. displayed to a user on a corresponding display unit. For example, this allows identifying abnormalities and/or the need for maintenance of the device etc.

[0037] Besides the coating application device described, the present invention also comprises the use of a coating application device according to any one of the

previously described embodiments, to spray a coating material of a surface of a storage tank. This is especially advantageous, as storage tanks may be located in windy regions, where it is of special importance to protect coating spray released from the spraying unit of such a device from wind effect, in order not to distort the spraying on a side wall of such a storage tank, and in order to be able to provide the storage tank with a homogeneous coating layer and/or, more generally, providing a coating layer with a precisely determined distribution pattern, e.g. a thickness distribution pattern. Moreover, the use of a coating application device according to the invention not only allows preventing wind effects from negatively influencing the coating procedure, but also protects the environment, as coating spray is prevented from being carried away into the surrounding by the wind.

[0038] Preferably, a surface to be sprayed is sprayed with a coating application device, wherein the base part comprises at least one contact point for contacting a surface to be sprayed, wherein the protecting unit comprises a shielding edge portion which is positioned or positionable in predetermined location with respect to the at least one contact point. In this case, it is preferable that the shielding edge portion is positioned such that, at least at an instance in time, a gap with a width between 1 mm and 300mm remains between the surface to be sprayed and the shielding edge portion. Hence, there is little or no danger that the shielding edge portion interferes with the surface to be sprayed, while the gap is small enough that little or no wind reaches coating spray through the gap. Preferably, the gap has a width between 5mm and 100mm, even more preferably between 10mm and 50mm or 15mm and 40mm, and most preferably between 25mm and 35mm.

[0039] The present invention also comprises a method for spraying coating spray on a surface to be sprayed using a coating application device with a base part comprising said at least one contact point, wherein the protecting unit comprises said shielding edge portion positioned or positionable in a predetermined location with respect to the at least one contact point. The shielding edge portion is then preferably positioned such that a predetermined gap is formed between the surface to be sprayed and the shielding edge portion. The gap may be constant along the shielding edge portion in some embodiments of the method, whereas it may vary along the extension of the shielding edge portion in other embodiments.

[0040] Preferably, the shielding edge portion is positioned such that the gap has a width between 1mm and 300mm, more preferably between 5mm and 100mm, even more preferably between 10mm and 50mm or 15mm and 40mm, and most preferably between 25mm and 35mm.

[0041] Additional advantages and features of the present invention, that can be realized on their own or in combination with one or several features discussed above, insofar as the features do not contradict each other

er, will become apparent from the following description of preferred embodiments.

[0042] The description is given with reference to the accompanying drawings, in which:

- Figure 1 shows an overall perspective view of a coating application device according to an embodiment of the invention;
- Figure 2 shows another overall perspective view of a coating application device according to an embodiment;
- Figure 3 shows a plane view of a coating application device according to an embodiment;
- Figure 4 shows a first cross-sectional view of a coating application device according to an embodiment;
- Figure 5A shows a second cross-sectional view of a coating application device according to an embodiment;
- Figure 5B shows a third cross-sectional view of a coating application device according to an embodiment; and
- Figure 6 shows a conceptual drawing of a coating application device according to an embodiment of the invention which is positioned on a side wall of a storage tank.

[0043] Figs. 1 and 2 show overall perspective views of a coating application device 10 according to an embodiment of the invention from two different perspectives.

[0044] The coating application device 10 is especially suited to spray a coating material such as a lacquer or paint onto an upwardly oriented cylindrical side wall of a storage tank. Said coating application device 10 comprises a base part 20 (comprising a plurality of sub-components, such as a frame and means for assisting displacements of the device 10 on the side wall of a storage tank, as will be discussed below), a spraying unit 30 configured to release coating spray, and a protecting unit 40, connected with said base part 10. Next, said base part 10, the spraying unit 30 and the protecting unit 40 will be discussed in more detail.

[0045] The base part 20 comprises a chassis 25, to which a set of wheels 21 are mounted (in the present case three pairs, i.e. a total of six wheels 21; see Fig. 2). Moreover, as can be seen in the cross-sectional views of Figs. 4, 5A and 5B, the base part 20 may also comprise a mounting rib 22 extending vertically in the drawing and leading up to a mounting point 23, at which the protecting unit 40 is attached to the base part 20.

[0046] The coating application device 10 is configured to contact an outer, vertically oriented side wall of a cy-

lindrical storage tank directly, by means of its wheels 21, and the device 10 is displaced by virtue of rolling across the wall on its wheels 21. Note that the device 10 is oriented substantially in a vertical direction, when being positioned on a substantially vertically oriented storage tank side wall to be sprayed.

[0047] The wheels 21 of the coating application device 10 each comprise a contact point p, where the wheels 21 (and thus the base part 20) is configured to contact the outer wall of a storage tank, as can be seen e.g. in the cross-sectional side views of Figures 5A and 5B (showing cross-sections from opposite directions). The six contact points p of this embodiment of the device 10 lie in a flat plane C, represented by a dashed line in Figs. 5A and 5B.

[0048] As can be seen e.g. in Fig. 4, the spraying unit 30 comprises a spraying arm 31 with a bar portion 32 and a nozzle mounting part 33, where a spraying nozzle 34 for releasing coating spray is installed. In the case of the present embodiment, the spraying unit 30 is configured to perform an airless spraying method, wherein a coating material such as paint or a lacquer is pressurized with a pump and then mixed with air in order to form the coating picture. The coating application device 10 therefore also comprises a coating medium pump 35 (see Figs. 5A, 5B) as a coating material supply unit for supplying coating material to the spraying unit 30.

[0049] The spraying nozzle 34 of the device 10 according to this embodiment has a diameter of 19", and, when the device 10 is in use, the spraying unit 30 of this embodiment is adjusted to release approximately 0.025 liters of coating material per second. This release rate is matched with the speed of displacements of the device 10, so that a coating layer with a thickness of approximately 60mm is formed on a wall of a storage tank being coated using the coating application device 10. Moreover, the nozzle 34 is positioned at such a distance from a surface to be sprayed and releases a beam with a width such that the width of a cone of coating spray reaching the side wall of a storage tank amounts to approximately 350mm.

[0050] The protecting unit 40 comprises a frame with first support bars 41, extending in surfaces substantially parallel to each other, and second support bars 42, interconnecting the first support bars 41, being joined with them at substantially perpendicular angles (see e.g. Fig. 1). The second support bars 42 extend to the aforementioned mounting point 23 at one of their ends, where the base part 20 and the protecting unit 40 are connected to each other. The frame is configured to absorb reaction forces and/or stress resulting in e.g. from an air pressure difference between air located between said protecting unit 40 and the outer wall of a storage tank and air located outside of the protecting unit, as well as from wind forces acting on the device 10. The frame is made of an alloy with a mechanical strength of approximately 150N/mm².

[0051] The protecting unit 40 further comprises a shielding part (not shown in the Figures), which can be

removably attached to the frame 40 and which serves as a wind shielding member, when the coating application device 10 is in use. In this embodiment, said shielding part is a surface which is closed in itself, i.e. it contains no holes. The shielding part has been omitted in the figures, in order to make the various components 'inside' of the device 10 visible.

[0052] The shielding part of the protecting unit 40 (not shown in the figures) protects coating spray from wind. When viewing the entire device 10 from above, i.e. from a direction substantially perpendicular to a storage tank side wall on which the device 10 is placed, the shielding part covers the entire region outlined by the frame depicted e.g. in Fig. 3. In other words, the shielding surface may be imagined to occupy the gaps remaining between the various supports bars 41, 42 in Fig. 3. As will be discussed in more detail below, a gap merely remains between a lower edge portion of the protecting unit 40 and a surface to be sprayed, wherein said gap lies approximately below the contour of the frame depicted in Fig. 3. Turning to Fig. 4 for example, the shielding surface reaches from the above-mentioned mounting point 23 all the way down to the lowest first support rib 44, among the plurality of first support ribs 41.

[0053] Together with a portion of the shielding surface in adjacent to said lowest rib 44, the lowest rib 44 and the mentioned lowest portion of the shielding surface form a so-called shielding edge portion 43, which forms a closed loop and extends around a part of the base part 20 (see Fig. 2). It has been referred to as a shielding 'edge' portion, as it might be viewed as a (lower) edge of a shielding portion of the protecting unit 40.

[0054] When the coating application device 10 is positioned on a substantially vertical side wall of a storage tank to be sprayed, and the device 10 is thus substantially oriented in a vertical direction, i.e. rotated 90° with respect to the orientations of the device 10 in Figs. 4, 5A and 5B, the shielding edge portion 43 thus extends in a substantially vertical direction as well. As the device 10 has to remain displaceable, without interfering with the storage tank side wall, e.g. without distorting the coating being formed on the storage tank side wall, the shielding edge portion 43 is not in contact with the wall to be sprayed, but a small gap remains between the surface to be sprayed and the shielding edge portion 43. The gap is chosen to be as small as possible, to allow as little wind as possible to reach any coating spray, released from the spraying nozzle 34, through said gap.

[0055] The former setting can be easily understood, when referring to Fig. 6, depicting an abstract schematic representation of an embodiment of a coating application device 10 according to the present invention. This embodiment of the device 10 may be imagined to be identical with the earlier discussed embodiment in most aspects. The only substantial difference regards the shape of the shielding edge portion 43, which shall be explained in detail.

[0056] Components of this embodiment of the device

10 that do not differ from those of the earlier discussed embodiment will be denoted by the same reference numerals. The device 10 depicted in Fig. 6 is placed on a surface to be sprayed S, namely a vertically oriented outer side wall of a cylindrical storage tank with a diameter of 60m. The schematic representation of Fig. 6 thus shows a section lying in a substantially horizontal plane. As can be seen in Fig. 6, the base part 20 contacts the surface to be sprayed S at the contact points p, provided on the wheels 21 of the base part 20.

[0057] The protecting unit 40 (the general contour of which is covered with a shielding surface, which has been made transparent in Fig. 6, for illustrative purposes) forms a protective shell around a substantial part of the base part 20 and almost reaches up to the surface S that is to be sprayed. However, a small gap G is left between the shielding edge portion 43 and the surface S of the storage tank to be sprayed. In the case of this embodiment, said gap G is constant along the shielding edge portion 43. However, said gap G may also vary. In particular, the (analogous) gap between a surface S to be sprayed and the shielding edge portion 43 varies in the case of the earlier discussed embodiment, when the surface to be sprayed is curved, as will be easily understood from the fact that the shielding edge portion 43 of this embodiment extends in a flat plane. In contrast, the shielding edge portion 43 of the embodiment shown in Fig. 6 extends in a curved plane. The curvature is adapted to the curvature of the surface S of the storage tank.

[0058] Moreover, note that the contact points p of the wheels 21 define a flat plane C (labelled by a dashed line in Fig. 6), which intersects the shielding edge portion 43. At the left and right end sections of the shielding edge portion in Fig. 6, the distance between the shielding edge portion 43 and the surface S to be sprayed is therefore smaller than the distance between the imaginary plane C, defined by the contact points p of the wheels 21 of the device 10, and said surface S to be sprayed.

[0059] The curvature of the shielding edge portion 43 may be modified accordingly, when designing an alternative embodiment of the coating application device according to the invention to be used to spray coating spray onto a different surface. For example, when spraying coating spray onto a flat surface, the embodiment of the invention depicted in Fig. 6 might not be convenient, as the shielding edge portion 43 may interfere with the surface being sprayed (at the left and right end sections in Fig. 6). On the other hand, when using an embodiment of the coating application device on a surface with a larger curvature radius (e.g. a part of a ship wall surface close to the bow), it may be convenient to have a shielding edge portion 43 with a larger radius of curvature, adapted to said surface to be sprayed.

[0060] It is also to be understood that it may be convenient to provide other embodiments of the coating application device with an adaptable protecting unit, e.g. wherein the shielding edge portions' position can be adapted to various regions of a surface being sprayed.

This is especially advantageous, when using the device on a surface with strongly varying geometry, i.e. with varying radius of curvature.

[0061] Turning back to Fig. 6, it can also be seen that the shielding edge portion 43 is positioned at a certain distance with respect to the contact points p. Thereby, the various points of the shielding edge portion 43 are each located at a specific distance with regard to (each of) the contact points p, wherein the distances between a contact point p and various points on the shielding edge portion 43 differ.

[0062] Both in the case of the earlier discussed embodiment and the embodiment of Fig. 6, the protecting unit 40 serves to shield a region 'inside of the protecting unit 40' from wind approaching from the outside. Thus, coating spray is efficiently protected from the wind. In this way, it is avoided that the wind distorts the spraying pattern applied to an outer side wall of a storage tank. Thus, a coating layer may be easily applied homogeneously onto said wall, and it is also prevented that the wind carries off coating spray into the surrounding, which also provides an advantageous protection of the environment from pollution by virtue of a coating material which may e.g. contain hazardous chemicals. The shielding edge portions 43 of the earlier discussed embodiment and of the embodiment shown in Fig. 6 extend fully around a part of the base part 20 and thus form a closed loop.

[0063] Turning back to the earlier discussed embodiment (see e.g. Figs. 5A and 5B), one can observe that the shielding edge portion 43 is located in a predetermined position with regard to the contact points p of the wheels 21. The wheels 21 define a flat plane, and in the case of this embodiment, the shielding edge portion 43 extends in parallel to said plane C.

[0064] If the earlier discussed embodiment of the coating application device 10 is positioned on a curved outer side wall S of a cylindrical storage tank, the shielding edge portion 43 is located slightly closer to the surface S at a middle position m in Figs. 5A and 5B than at the left and right end portions, due to the curvature of the surface to be sprayed S. Thus, also the gap G between the shielding edge portion 43 and said surface S is slightly larger towards the left and right end sections. However, as long as the surface S is not too severely curved, the gap G is still small enough to obtain a technically advantageous effect of effectively protecting coating spray released from the spraying unit 30 from wind. The earlier discussed embodiment of a coating application device 10, depicted in Figures 1-5B is thus also suitable for use on a side wall of a storage tank with a diameter of, say, 60m.

[0065] Moreover, as shown e.g. in Fig. 4, the protecting unit 40 of the earlier discussed embodiment of the present invention is shaped so as to promote wind being guided away from coating spray at the shielding edge portion 43 and in a region R adjacent to the shielding edge portion 43. The shape is adapted such that wind approaching the shielding edge portion 43, or more gen-

erally the region R, is not guided towards a gap G between a surface being sprayed S and the shielding edge portion 43, but rather guided away from said gap. Thus, wind is also guided away from coating spray released from the spraying nozzle 43.

[0066] As depicted in Figs. 1-5B, the protecting unit 40 of the earlier discussed embodiment is dome-shaped. The dome-shape resembles an ellipse in when viewed from above (see Figure 3), whereas it slightly resembles a part of a storm umbrella from a perspective view (see Figs. 1 and 2). This geometry is especially suited to provide a good resistance against strong winds. The advantage thereof is that the device is wind-proof up to high wind speeds (in the case of the present embodiments: wind speeds over 100km/h), so that the coating application device is not moved even by strong wind gusts or the like. The anti-symmetric shape of the protecting unit 40 along a direction of its longest extension can be nicely seen in Fig. 4, wherein Fig. 4 is a section along the long middle axis of the ellipse-like contour shown in Fig. 3, edged by the shielding edge portion 43.

[0067] The shielding surface (not shown), which is mounted on the frame comprising the support bars 41, 42 is closed in itself, meaning that it comprises no holes. This means that the shielding surface, when viewed from above (see e.g. Fig. 3), 'covers' the entire ellipse-like contour. The shielding surface is in this case provided as a removable component, and the figures depict a state of the device 10 wherein the shielding surface has been removed from the frame. The removability of the shielding surface is especially advantageous, as the shielding surface may be easily replaced upon contamination e.g. with coating spray on its inside surface, without requiring the replacement of any other components of the coating application device. In the case of the present embodiment, said shielding surface is provided by virtue of a wind screen, made of a disposable material, which is environment-friendly and thus suitable for being disposed upon replacement with a new shielding surface. However, the shielding surface may be recyclable in the case of other embodiments.

[0068] As will become apparent from comparing the various perspectives of the coating application device according to the earlier discussed embodiment (see Figures 1, 2 and 5A, 5B in particular), the protecting unit 40 is dimensioned such that it encapsulates the vast majority of the base part 20, together with a surface to be sprayed such as the outer side wall of a storage tank. The base part 20 is then almost fully encapsulated, up to the formerly mentioned small gap G present between the shielding edge portion 43 and said wall. In the present case, a wall of a storage tank with a diameter of 60m and the protecting unit 40 encapsulate more than 95% of the base part 20.

[0069] Furthermore, the wheels 21 of the earlier discussed and this embodiment of the device 10 are magnetized, so that the coating application device 10 can be moved across a side wall S of a storage tank using a

magnet located on the other side of said wall, i.e. inside of a storage tank. Moreover, the magnetic force keeps the device 10 steadily on the wall, even when in a vertically oriented position. In the present case, the coating application device is preferably displaced on the side wall of a storage tank, in practice, at a speed approximately between 0.6m/s and 1.1 m/s. Moreover, the acceleration of the device is preferably kept at a value equal to or smaller than 10m/s².

[0070] Furthermore, the coating application device according to this embodiment comprises two sensors 50 configured to acquire data regarding the thickness of a coating layer applied to a surface being sprayed S (see Figures 2 and 3 in particular). The sensors 50 are mounted on corresponding mounting portions 51 located at the side of the device in proximity to the shielding edge portion 43 (see Figure 5A and 5B). Said mounting portions 51 are provided on sensor support bars 52 (see Figure 3), and the entire frames (including the mounting portions 51 and the support bars 52) of the sensors 50 are made of an alloy material with a yield stress of approximately 150N/mm². The support bars 52 are rigid enough, so that the sensors 50 remain in a steady position during a coating process, despite wind effects etc., without interfering with any other component of the coating application device 10 such as the protecting unit 40, ensuring that the sensors 50 provide reliable data.

[0071] The sensors 50 of the earlier discussed embodiment of the present invention are eddy current sensors, configured to establish data on coating thicknesses between 2mm and 50mm. However, sensors working according to a different principle can be employed in other embodiments. Moreover, additionally or alternatively, a sensor may be provided that is arranged to acquire data on the distance of a part of the device 10 (such as a part of the shielding edge portion 43 or of the spraying nozzle 43) and the surface being sprayed S.

[0072] Although this is not the case for the embodiment depicted in the figures, the protecting unit may be at least partially collapsible in the case of other embodiments, similar to a roof of a convertible. For example, this may be realized by virtue of a mechanism attached to the frame of the protecting unit 40, arranged to fold the shielding surface (not shown) together fully or partially, e.g. by moving it all to one side and assembling it in a longitudinal portion, for example close to a part of the shielding edge portion 43.

[0073] The invention is not limited to the embodiments described herein. Numerous variations and modifications are understood to also fall within the framework of the invention. For example, the coating application device could be provided with an additional adjustment mechanism for adjusting the position of at least a part of the protecting unit. In particular, the adjustment mechanism could be arranged to alter the angle of inclination of a portion of the protecting unit 40 in the vicinity of the shielding edge portion 43, in order to change the width of the gap. Moreover, the device could comprise an ad-

ditional controller configured to control the adjustment mechanism, e.g. depending on the data acquired by the sensors 50 or additional or alternative sensors. Moreover, the earlier discussed embodiment of a coating application device is specifically configured for use with a storage tank with a diameter of approximately 60m. However, the skilled person will conceive modified embodiments of a coating application device according to the present invention, based on the present disclosure of the invention, particularly suited for use with other storage tanks (e.g. with a diameter of 30m or 80m) by altering the dimensionalities of the components of the device. The dimensions can also be adapted accordingly if a coating application device is to be used on a different type of building or, for example, to coat an outer surface of a ship.

[0074] Many additional variations and modifications are possible and are understood to fall within the framework of the invention.

Claims

1. Assembly for forming a coating application device configured to spray a coating material onto a surface to be sprayed (S) with a coating material, said assembly comprising:

a base part (20) configured to cause or assist displacements of the coating application device (10) with respect to a surface to be sprayed (S), a spraying unit (30) configured to release coating spray; and

a protecting unit (40) configured to be fixedly or removably connected with said base part (20) and to protect coating spray against wind, wherein the protecting unit (40) is at least partially dome-shaped.

2. Assembly for forming a coating application device according to claim 1 in assembled condition.

3. Assembly for forming a coating application device according to claim 1 or 2, wherein the protecting unit (40) comprises:

at least one shielding part with an interior side facing at least a part of the spraying unit (30) and an exterior side facing away from said part of the spraying unit (30), the shielding part being configured to shield off coating spray, when present between said part of the spraying unit (30) and a surface to be sprayed (S).

4. Assembly for forming a coating application device according to any one of the preceding claims, wherein

said base part comprises at least one contact point (p) for contacting a surface to be sprayed (S), and wherein

said protecting unit (40) comprises a shielding edge portion (43) which is positioned or positionable in a predetermined location with respect to the at least one contact point (p).

5. Assembly for forming a coating application device according to claim 4, wherein the shielding edge portion (43) at least partially surrounds the base part (20). 5
6. Assembly for forming a coating application device according to claim 4 or 5, wherein 10
said base part (20) comprises at least three contact points (p), including said at least one contact point (p), defining a flat plane (C) or a curved plane, and the shielding edge portion (43) is positioned or positionable at a predetermined distance with respect to said plane (C). 15
7. Assembly for forming a coating application device according to any one of claims 4 to 6, wherein the protecting unit (40) is shaped, at least at a part of the shielding edge portion (43) and/or a part adjacent to the shielding edge portion (43), so as to promote wind being guided away from coating spray. 20
8. Assembly for forming a coating application device according to any one of the preceding claims, wherein 25
the protecting unit (40) comprises at least one shielding surface which is closed in itself or comprises at least one hole. 30
9. Assembly for forming a coating application device according to claim 8, wherein the shielding surface is configured to be removable. 35
10. Assembly for forming a coating application device according to any one of the preceding claims, wherein the protecting unit (40) is dimensioned such that, together with a surface to be sprayed (S), it encapsulates between 30% and 99,9% of the base part (20). 40
11. Assembly for forming a coating application device according to any one of the preceding claims, further comprising a coating material supply unit (35) for supplying coating material to the spraying unit (30), and wherein the base part (20) comprises at least one wheel (21). 45
12. Assembly for forming a coating application device according to any one of the preceding claims, wherein at least a part of the base part (20) is magnetized or magnetizable. 50

13. Assembly for forming a coating application device according to any one of the preceding claims, further comprising an adjustment mechanism for adjusting the position of at least a part of the protecting unit (10). 55

14. Assembly for forming a coating application device according to any one of the preceding claims, further comprising at least one sensor means (50) configured to acquire data on a distance between a part of the device and a surface to be sprayed (S) and/or the thickness of a coating layer applied to a surface to be sprayed (S), and a controller configured to control the adjustment member using said data.

15. Method for spraying coating spray on to a surface to be sprayed using an assembly according to any one of claims 4 to 7, wherein the shielding edge portion (43) is positioned such that a predetermined gap (G) is formed between the surface to be sprayed (S) and the shielding edge portion (43), the gap (G) having a width between 1 mm and 300mm.

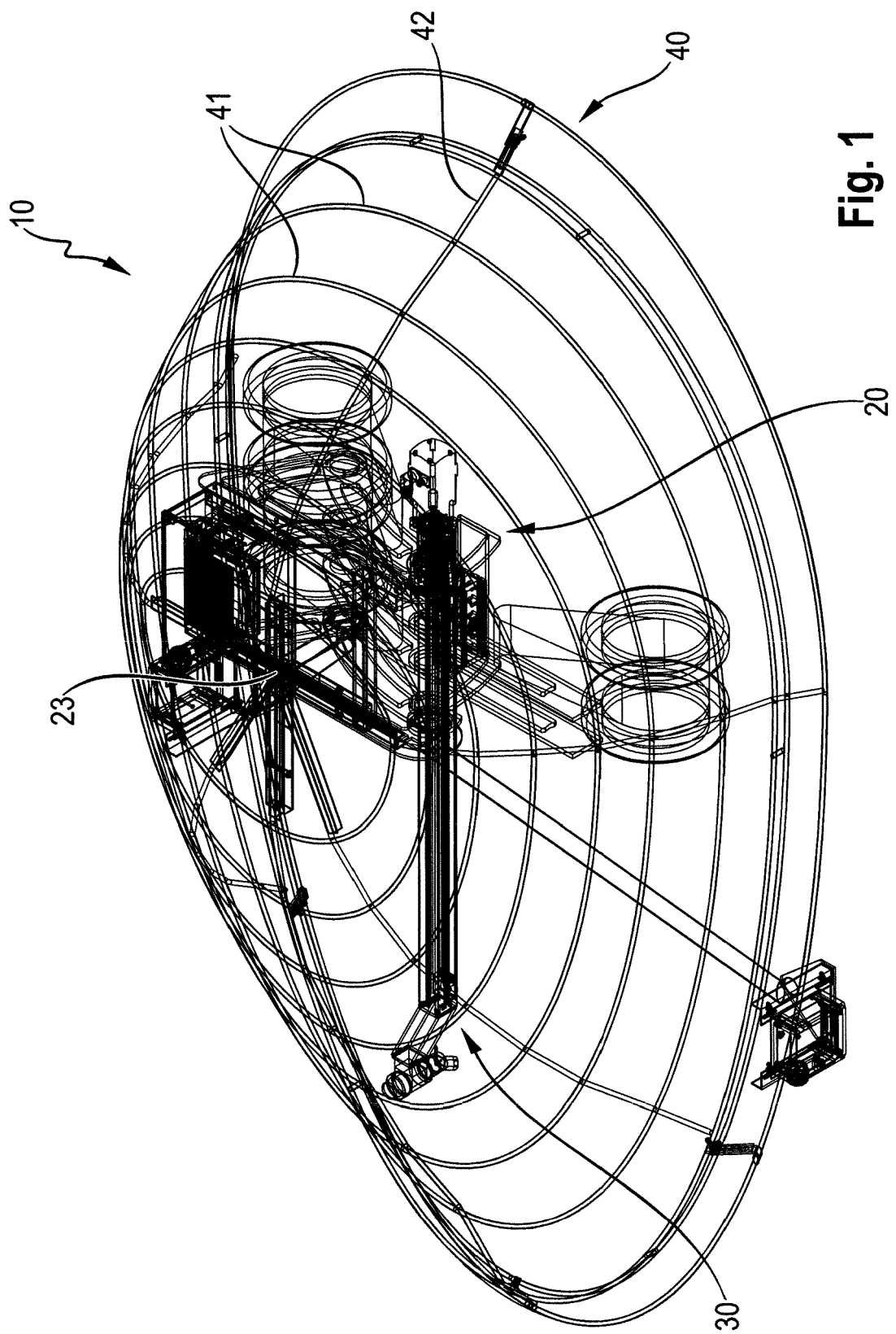


Fig. 1

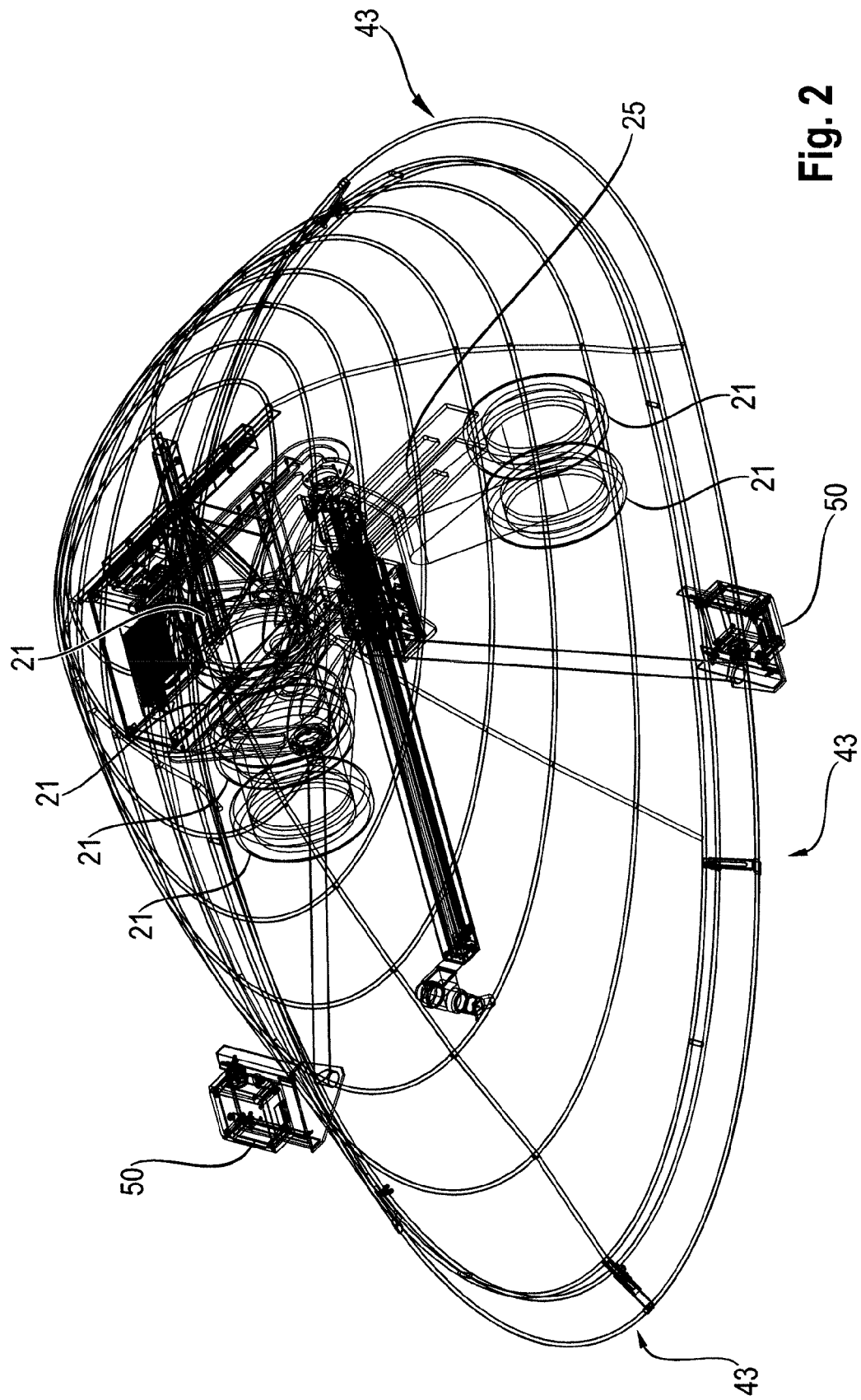


Fig. 2

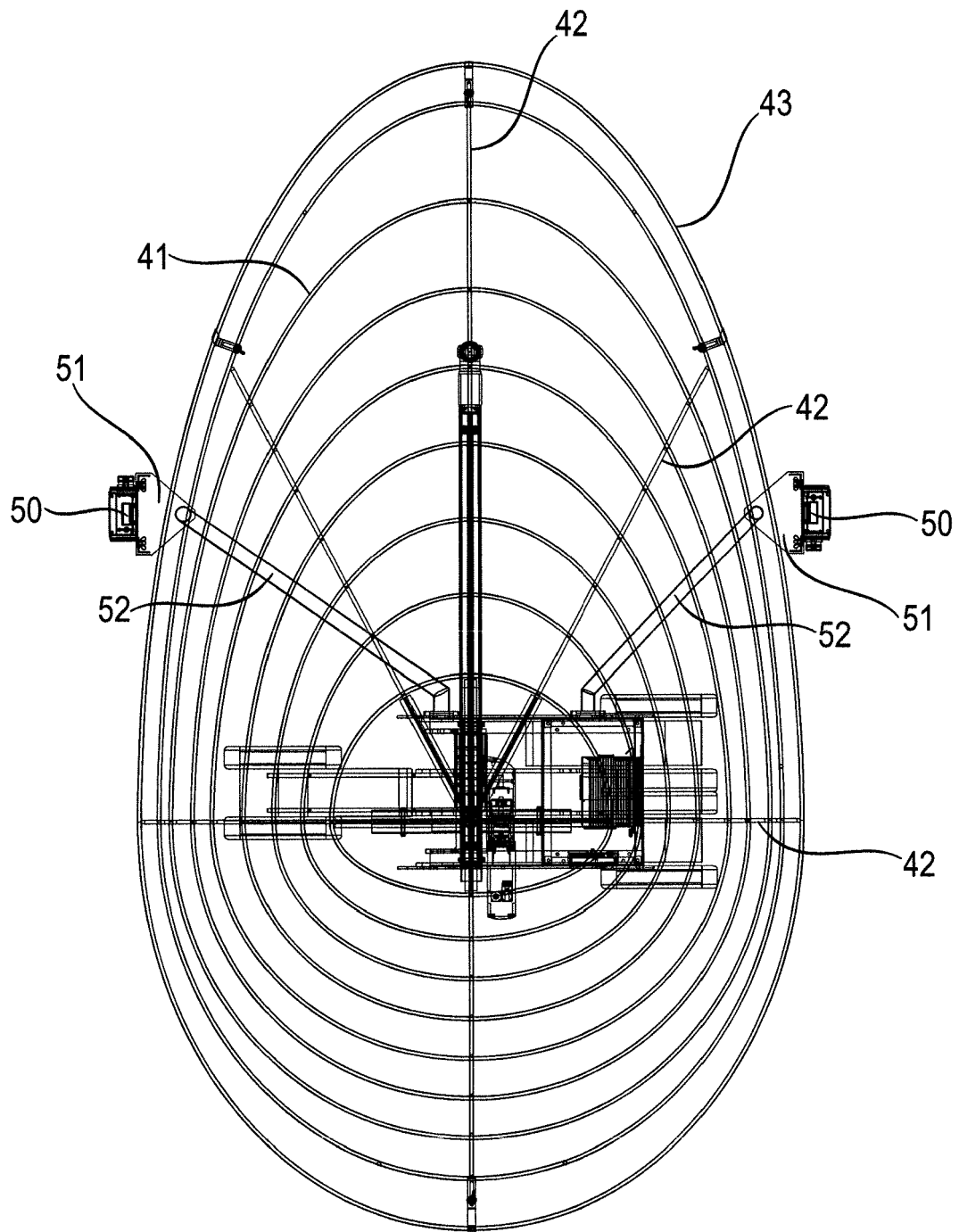


Fig. 3

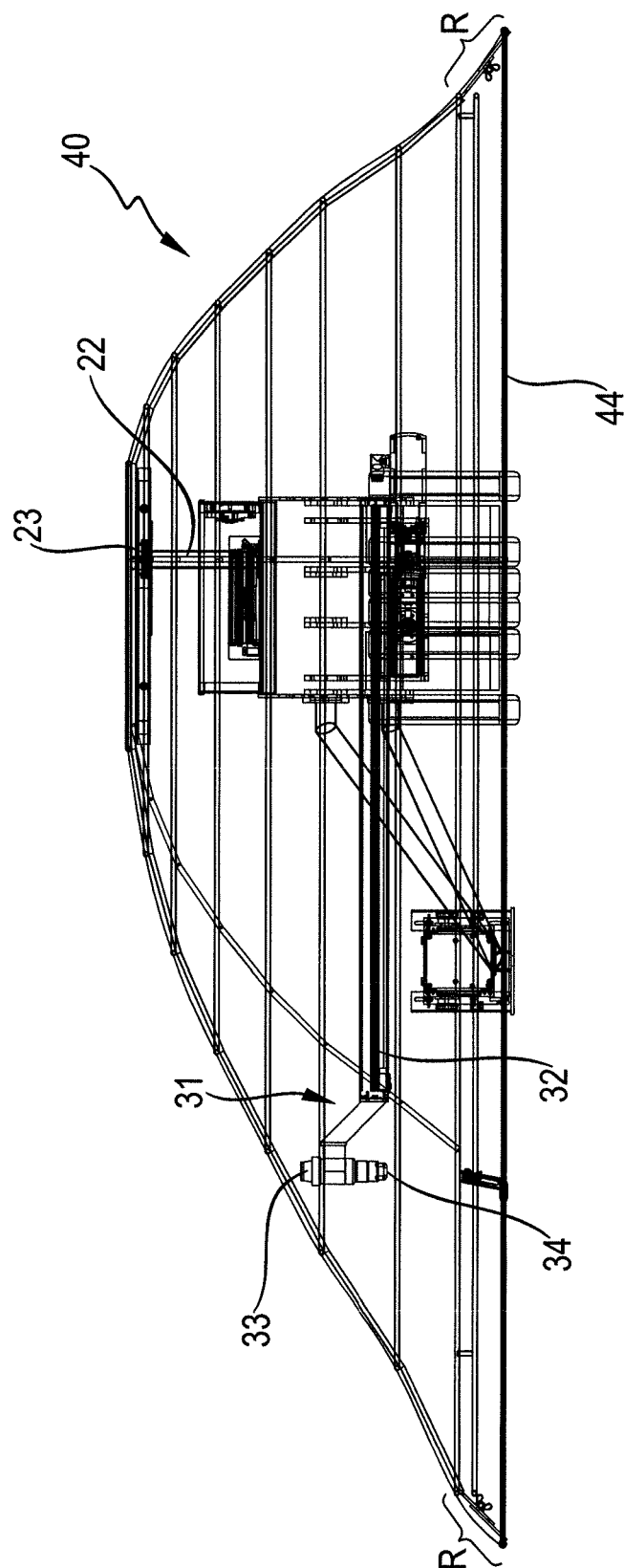


Fig. 4

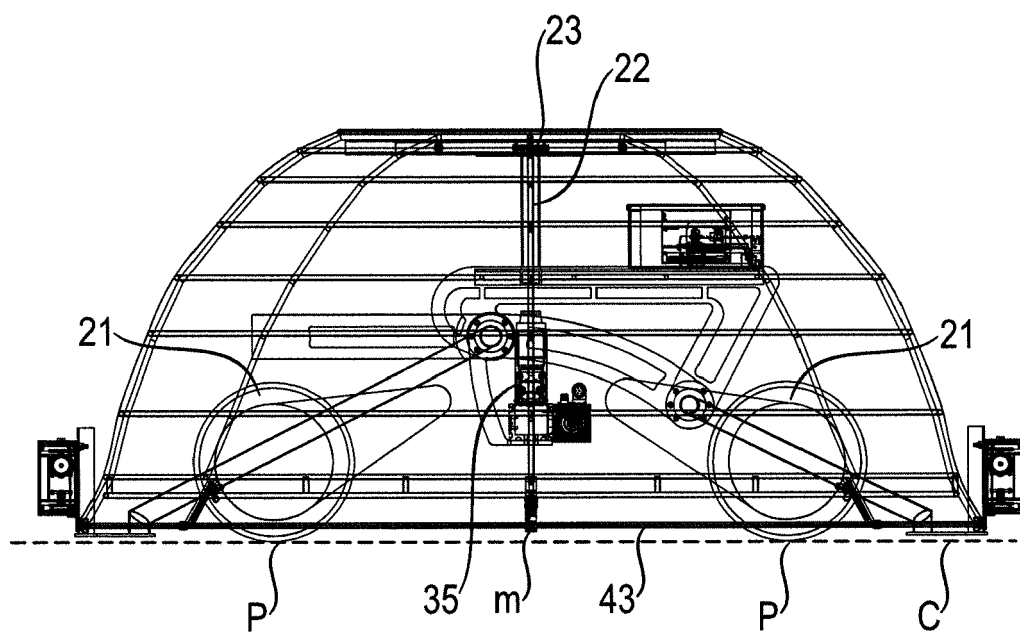


Fig. 5A

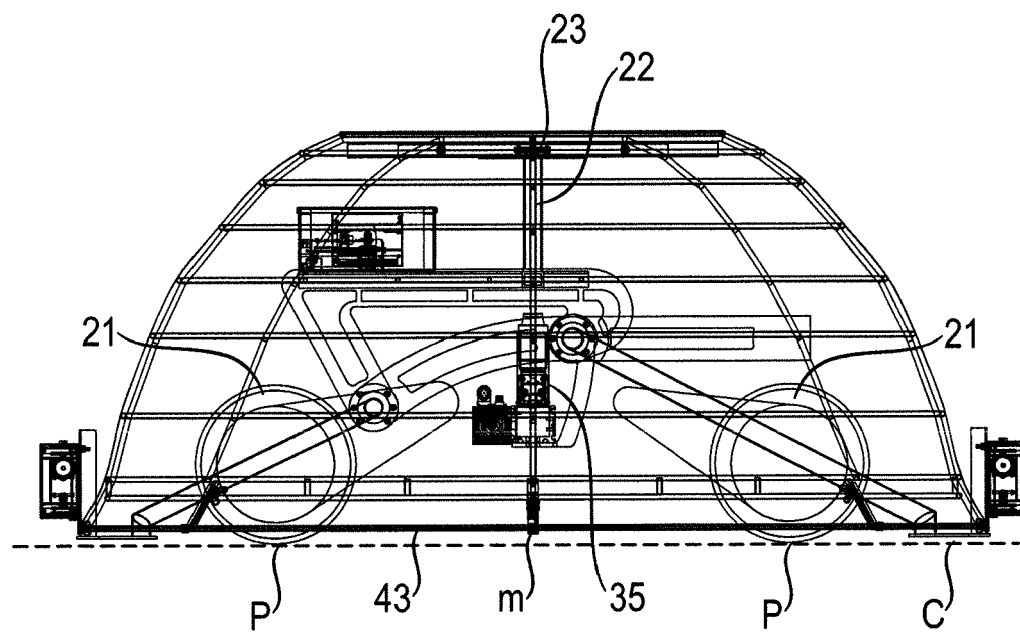


Fig. 5B

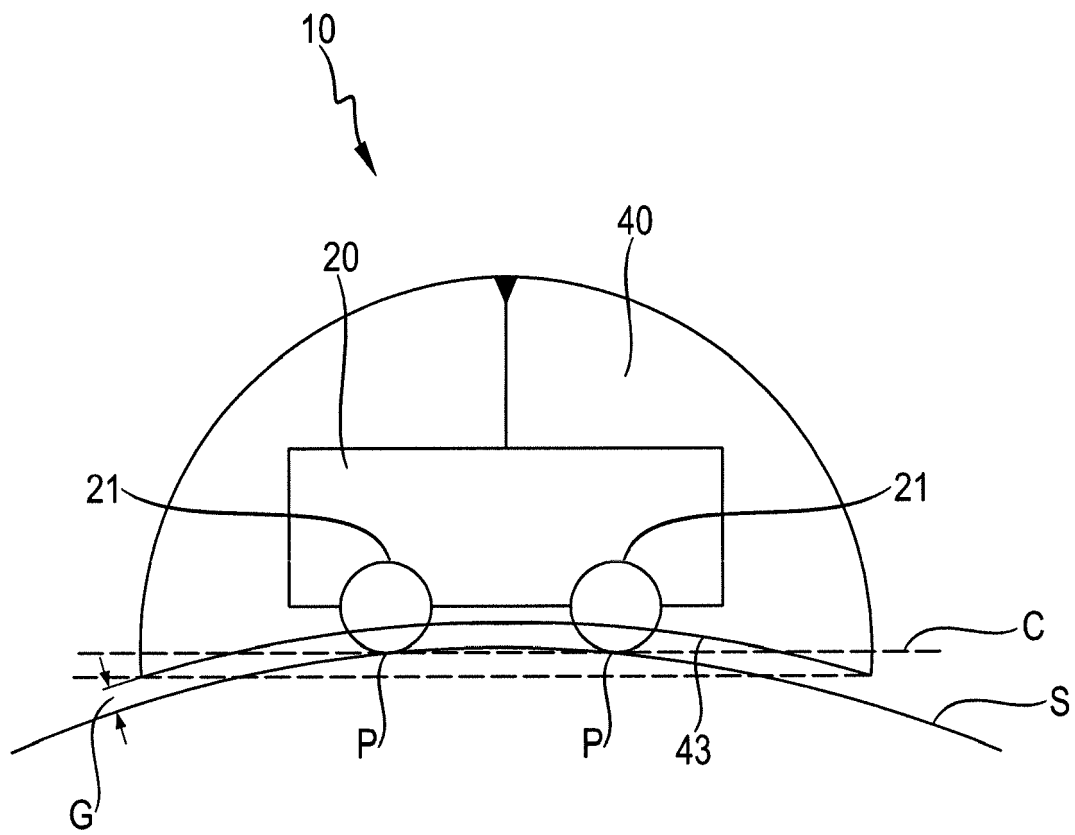


Fig. 6



EUROPEAN SEARCH REPORT

 Application Number
 EP 15 19 4530

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 March 2016	Examiner Innecken, Axel
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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