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(54) GUIDE AND FEEDER SYSTEM FOR A WINDABLE MATERIAL

(57) A guide (203) for guiding an elongate windable material (202) from/to a drum (201), the guide (203) comprising a guide housing (212) for containing a displaceable section of the winding material (202) and configured to maintain a rotatable main pulley (204) and two rotatable auxiliary pulleys (205, 206) in a fixed spatial relationship with each other, wherein the axes (204a, 205a, 206a) of the pulleys (204, 205, 206) are parallel to each other and perpendicular to the longitudinal axis of the section of windable material (202) contained in the housing (212). The windable material (202) is displaceable between the main pulley (204) and the two auxiliary pulleys (205, 206), the main pulley (204) and the auxiliary pulleys (205, 206) engaging respectively with a first surface of the windable material (202) and a second surface of the windable material (202), the second surface being opposite the first surface.

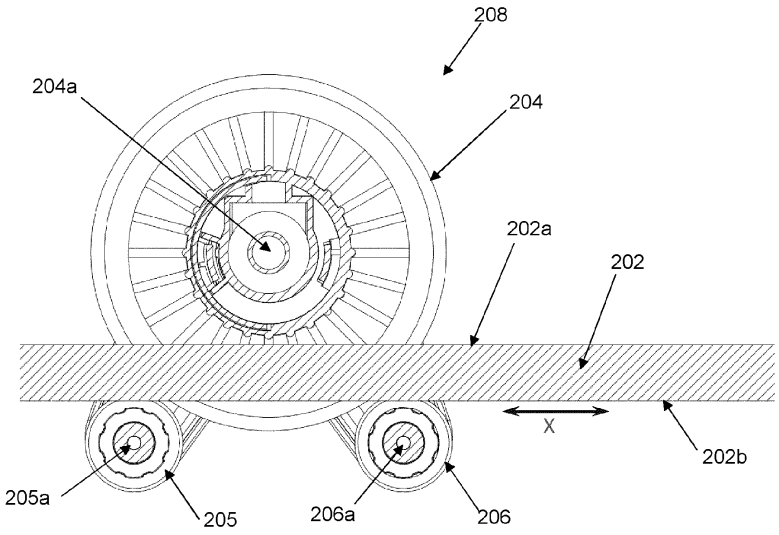

Figure 3A

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the storage, winding and unwinding of hoses, pipings, cables, threads, strings and any elongate material capable of being wound ("windable") on reels or drums of generally circular cross-section. It relates to improved reels/drums, reel/drum guides and reel/drum feeder systems, and associated processes for any windable material. In particular, this disclosure relates primarily, but is not limited to, hose reel guide and feed systems used in horticulture, agriculture, irrigation, and general water transportation systems.

[0002] Guide and feeder arrangements for reels permit and control the unwinding and/or (re)winding of the windable material from and/or onto a drum, reel, bobbin or similar, about which the windable material may be maintained. The windable material may be modified from a "wound" state, in which it is wound, for storage, about the drum, reel, bobbin or similar, to an "unwound" state, in which the coils or portions of windable material are removed from the drum, reel, bobbin or similar, such that uncoiled or unwound parts of the hose or similar are extended or unfurled toward an objective or destination and away from the drum, reel etc. The windable material may also be in any intermediate state between being completely wound and completely unwound, such that a portion of the windable material has been unwound, while a portion continues to be wound.

[0003] A guide or feeder seeks *inter alia* to ensure that the windings of the windable material in a wound state are uniformly distributed over the longitudinal dimension of the drum/reel and that an uneven "bunching up" of the hose on one part of the drum/reel is avoided.

[0004] The subject-matter disclosed herein may be equally applied in systems for any elongate flexible material capable of being wound or unwound on/from a drum/reel, including cables and non-hollow windable materials, as well as to general hollow windable materials, such as liquid supply systems (not only water), fire control and other fluid delivery systems using hoses or flexible tubular pipes or piping. The expressions "windable" or "windable material" shall herein refer to all such materials: for brevity, some references herein are simply to "material".

[0005] The word "hose" shall refer herein to any windable flexible tubular pipe/piping containing a continuous longitudinal cavity and suitable for fluid transportation and supply. The word "drum" shall refer herein to any drum, reel, bobbin or similar, onto which a windable material may be wound to store the windable material. The cross-section of the drum disclosed, discussed and illustrated herein may be circular in form, and may include drums which are cylindrical in form, but include rounded or partially rounded geometries, such as generally cylindrical forms in which the curved surface is arcuate, or concave, in cross-section, to enhance the storage function of the drum, or may have any form suitable for supporting the windings of a hose.

BACKGROUND OF THE INVENTION

[0006] As stated above, winding material should be evenly distributed over the drum's longitudinal axial dimension. Non-uniform distribution can lead to twisting, kinks or bends or other damage to the winding material as it unwound or rewound from/onto the drum.

[0007] In the case of hoses or hose-like piping there are additional considerations. The ability of a hose to pass fluid depends on the hose cavity being free from blockage and the mechanical integrity of the hose wall. Firstly, passage of the fluid along the hose will be reduced or prevented by an occlusion in the cavity, such as a constriction of the hose due to a compressing mechanical force or other deforming action, or by a bend or kink in the hose. These all serve to reduce in the cavity's cross section and therefore the flow rate of the fluid in the hose. Secondly, the integrity of the hose wall is fundamental to the hose's water delivery capacity: in short, a fractured or damaged hose wall will be subject to fluid leakage. Such mechanical damage to the hose occurs when the hose is twisted, bent or kinked or subject to excessive forces imposed on the hose.

[0008] For the reasons set out above, kinks, twists, tangles and other deformations of the hose or other windable material can limit or prevent flow capacity or cause permanent mechanical damage to the hose or other windable material. Such deformations are particularly likely to occur on those portions of the windable material being unwound, or "peeled" away, from the material windings mounted on the drum: the windable material is removed from its wound state by the application of a mechanical force aligned longitudinally with the axis of the portion being removed, but if such mechanical force is misdirected/misaligned, excessive deformations can easily occur. The reader will understand that similar problems may occur when the windable material is rewound back onto the drum.

[0009] The user is therefore obliged to monitor, and or regulate by hand, the unwinding (peeling) or re-winding process to avoid such deformations occurring, which is clearly burdensome and inconvenient.

[0010] In seeking to ensure that both deformations are minimised and material lifetime is maximised, drum systems for storing, by winding, flexible elongate materials (the windable materials) on drums sometimes include guides or feeders (hereinafter referred to simply as "guide(s)"), which seek to minimise the occurrence of such deformations, especially as part of the material is unwound (or "peeled" away) or rewound, from/to the wound portion of the material, the guide being attached to the drum. Arrangement(s) which comprise a drum and a guide are generally referred to herein as "guided system(s)" or, for brevity, some references are simply to

"system(s)".

[0011] The guides in conventional guided systems typically comprise a guide bar aligned perpendicular to the windings of the windable material on the drum and in the same horizontal plane as the drum axis. The guide may also comprise a movable guide carriage capable of longitudinal displacement along the guide bar and suitable for guiding the elongate material which pass over it. In some guide variants the guide carriage may comprise a pulley rotatable coaxially about the guide bar, over which the unwinding/rewinding material passes from/to the material wound on the drum. The guide carriage may move synchronously up/down the guide bar with the unwinding/winding of the material from/to the drum, to achieve an even removal/loading of the material on the drum. A further cover element may be present to constrain the contact of the unwinding/winding material with the guide carriage as the guide carriage moves up/down the bar.

[0012] However, conventional guides suffer from a number of shortcomings. One notable technical disadvantage of conventional guides is that the angular position of the guide with respect to the drum is fixed. In the case of the conventional guide bar described above the bar is located in the same plane as the drum axis, meaning engagement of the unwound portion of the windable material with the bar is dependent on the direction in which the windable material portion is pulled, as described below. The material can be pulled in directions which reduce or prevent engagement: the divergences of the pulling from the normal direction can be in a vertical plane (making an angle $\alpha°$ with the horizontal plane) or can be in horizontal plane (making an angle $\beta°$ with the vertical plane), as discussed below, or a combination of these two. In the absence of any engagement the guiding is disrupted or eliminated, such that the material may be bent or kinked and blockages or mechanical damage may ensue. Even in guide variants with a displaceable pulley the engagement of the windable material with the pulley is still dependent on the direction in which the windable material is pulled as it is peeled from the material windings on the drum.

[0013] Conventional guides can therefore only be used at specific "peeling" angles: outside a defined range no guidance occurs, the range of angles being also dependent on the relative position of the guide with respect to the drum. In the worst-case scenario using a conventional guided system the windable material may be tugged out of the guide area, leading to further kinks and entanglement. The reader will appreciate that inadvertent pulling of the material in a direction outside this range, in which guidance does not occur, will happen easily and frequently: in a horticultural setting, for example, it is highly likely that a user, watering plants, will pull a hose out of the guide range. Users of conventional guides are obliged to intervene when such entanglements occur to rectify the entanglement or kink, thereby losing time from their watering activity.

TECHNICAL OBJECTIVE

[0014] It is an objective of the arrangement and method herein disclosed to overcome the shortcomings of prior art apparatuses and methods indicated above.

[0015] It is a further objective of the arrangement and method disclosed herein to provide a guide for a guided system which automatically and continuously minimises the likelihood of entanglement, kinks, bends or other deformations of the windable material when removing or re-winding portions of the windable material from/onto the material windings stored on the drum. Mechanical damage to the windable material is thereby reduced.

[0016] A technical advantage of the arrangement and method disclosed herein is that the guidance function is provided irrespective of the relative location/orientation of the guided system. A further advantage of the arrangement and method disclosed herein is that, unlike the use of conventional systems with the guides, the range of angles over which the hose may be pulled by the user (the peeling angle) is unlimited, leaving the user to focus on watering activities rather than on avoiding hose kinks or tangles.

[0017] The inventive arrangement and method disclosed herein minimises user monitoring and user intervention.

STATEMENT OF THE INVENTION

[0018] This disclosure relates to a novel and inventive apparatus and method for guiding and feeding a windable material from or to a drum.

[0019] An exemplary aspect of the apparatus and method herein disclosed is directed to a guide for guiding an elongate windable material from/to a drum, the guide comprising a guide housing for containing a displaceable section of the winding material and configured to maintain a rotatable main pulley and two rotatable auxiliary pulleys in a fixed spatial relationship with each other, wherein: the axes of the pulleys are parallel to each other and perpendicular to the longitudinal axis of the section of windable material contained in the housing; the main pulley is configured to engage with a first side of the material section, and; the auxiliary pulleys are configured to engage with a second side of the displaceable material section opposite the first side of the material section.

[0020] In accordance with another exemplary aspect of the apparatus and method of this disclosure the guide housing is freely rotatable about an axis parallel to the axes of the pulleys.

[0021] According to another embodiment of the apparatus and method herein disclosed the guide housing is rotatable about the axis of the main pulley.

[0022] In another aspect of the arrangement and process herein disclosed the rotation of main pulley is independent of the rotation of the guide housing.

[0023] In accordance with an embodiment of the arrangement and method of the present disclosure the ro-

tational axes of the two auxiliary pulleys are equidistant from the rotational axis of the guide housing.

[0024] In a further exemplary aspect of the apparatus and method disclosed herein, a first plane contains the rotational axis of the main pulley and one of the auxiliary pulleys and a second plane contains the rotational axis of the main pulley and the other of the auxiliary pulleys, wherein the first and the second plane intersect at the rotational axis of the main pulley and the angle between the first and the second plane at their intersection is fixed.

[0025] According to an embodiment of the arrangement disclosed herewith, the angle between the first plane and the second plane is 70°.

[0026] In an exemplary aspect of the apparatus and method disclosed herein the two auxiliary pulleys are configured to constrain the material section into engagement with the main pulley.

[0027] In accordance with an exemplary embodiment of the apparatus and methodherein disclosed the rotatable guide housing is configured to automatically adjust its orientation and, wherein, after the self-adjustment, the auxiliary pulleys are symmetrically disposed about a vertical through the main pulley.

[0028] In a further aspect of the arrangement and method herein disclosed the guide further comprises a guide carriage displaceably mounted on a guide bar, wherein the guide carriage comprises the guide housing as described above.

[0029] In a further embodiment of the arrangement and method of the present disclosure the displacement of the guide carriage along the guide bar is a function of the longitudinal displacement of the windable material in the guide.

[0030] In an exemplary aspect according to an embodiment of the arrangement and method herein disclosed the rotational axis of the guide housing is the longitudinal axis of the guide bar.

[0031] In accordance with an embodiment of the arrangement and method disclosed herein the elongate windable material is a hose for horticulture, gardening, irrigation or watering.

[0032] In a further aspect of the arrangement disclosed herein a system comprises a drum for storing windings of windable material and a guide as described above, wherein the guide is attached to the drum and is configured to guide the windable material as it is unwound/rewound from/to the windings stored on the drum.

[0033] In accordance with an embodiment of a process disclosed herein for guiding an elongate windable material from/to a drum the process comprises the steps of: maintaining, in a guide housing for containing a displaceable section of the winding material, a rotatable main pulley and two rotatable auxiliary pulleys in a fixed spatial relationship with each other, and configuring the axes of the pulleys parallel to each other and perpendicular to the longitudinal axis of the section of windable material contained in the housing, the main pulley to engage with a first side of the material section, and the auxiliary pulleys to engage with a second side of the displaceable material section opposite the first side of the material section.

BRIEF DESCRIPTION OF THE FIGURES

[0034] Reference is now made to certain embodiments of the inventions, one or more examples of which are illustrated in the accompanying drawings.

Figures 1A and 1B illustrate a guided drum system of the prior art;

Figures 2A and 2B are side and front views of an embodiment of a guided system according to the invention in a first orientation, with Figure 2A being in cross-sectional view;

Figures 3A and 3B are side views of an embodiment according to the invention, in cross-section and external view;

Figures 4A and 4B are general views of an embodiment according to the invention, with and without a portion of windable material;

Figures 5A and 5B are schematic drawings of an embodiment of a guide according to the invention;

Figures 6A and 6B are side and top views of an embodiment according to the invention, with the windable material being pulled in different angles.;

Figures 7A and 7B are side views of an embodiment of a guided system according to the invention in a second orientation;

The description makes use of certain numerical and letter references as appropriate to refer to features in the drawings. The same or similar references in the drawings and description have been used to indicate the same or similar parts of the arrangement.

DETAILED DESCRIPTION OF THE FIGURES AND EMBODIMENTS

[0035] Unless indicated otherwise by the context, the terms "first", "second", "third", "next", "last", etc, as well as "left", "right", "upper", "lower", "highest", "higher", "lowest" and "lower" are adopted to distinguish one component from another, and are not intended to define the position, chronology, location or importance of the components specified. Such terms are used herein to explain the various aspects disclosed herein but do not limit the alignment or structure of the embodiments described herein. The singular forms "a", "an", and "the" include plural references, unless, based on the context, this is clearly not the case.

[0036] Reference will be made in detail to examples and embodiments of the guide for a windable material, including for a hose, one or more of which are illustrated in the drawings. The embodiments and examples are provided for the purpose of explanation and not to limit the invention in any way. It will be apparent to those skilled in the art that various modifications and variations may be made in the present invention within the scope of the invention which is defined in the claims. Features illustrated or described as present in any one embodiment may also be used with another embodiment, thereby providing a yet further embodiment. The present invention covers any variations, amendments and modifications which fall within the scope of the accompanying claims and their equivalents.

[0037] Various embodiments, aspects and implementations of the present invention, as well as technical objectives and advantages will be apparent to those skilled in the art, upon consideration of the description herein, in combination with the drawings.

[0038] Fig 1A shows a conventional guided system (101, 103), in which a guide (103) is attached to a drum (101), the guide comprising a guide bar (107) aligned parallel to the axis of the drum and perpendicular to a portion of the windable material (102) as it unwinds from the windings on the drum (101) and a guide carriage (104). The guide carriage (104) may generally be shaped to guide the moving unwound section of the windable material (102) as it unwinds/rewinds from/to the drum (101) and may be displaceable along the length of the guide bar (107), wherein the guide carriage (104) may be displaced along (up or down) the guide bar (107) synchronously with the unwinding/rewinding of the windable material (102). In some conventional guides the guide bar (107) may further comprise a double threading (opposing helical threads) on its surface: a rotary unit (not shown herein) within the guide carriage (104) is forced into rotation by the displacement of the hose or other windable material in the carriage (104) and cooperates with the double threading of the guide bar (107) to displace the guide carriage (104) longitudinally along the guide bar (107). The rotary unit is configured to reverse the direction of movement along the guide bar (107) when the guide carriage (104) reaches an end of the guide bar (107). The rotary unit described above forms part of the known art and is not described herein in further detail.

[0039] The guide carriage (104) for guiding the unwinding/rewinding hose (or other windable material) may further comprise a pulley (as shown in Fig 1A) which can engage with the moving material (peeling from/onto the drum (101) and is free to rotate about the axis of guide bar (107): as well as moving longitudinally along the guide bar (107), the pulley may rotate about the guide bar (107), thereby removing the windings of wound material from the drum or rewinding the material onto the drum.

[0040] As alluded to previously, conventional guides are effective only over specific angular ranges: Figure 1B shows the "normal" pulling force on the windable material being directed outward (shaded broad arrow) such that the windable material, eg a hose, correctly engages with the guide carriage (104) of the guide. However, it will be readily understood by the reader that if the windable material is pulled in a different direction the guidance function of the guide carriage (104) may be lost: if, for example, (in the sense of Fig 1B) the unwound material were pulled vertically upwards (denoted by the bold double-headed arcuate arrow), or even back toward the drum, the windable material could become disengaged from the guide. If it is tugged in a lateral direction, ie parallel to the guide bar (107), as denoted by the other double-headed arcuate arrow) the windable material may become kinked or deformed by the guide or disengaged from the guide, thereby defeating the objective of the guide. As stated above, such deformations and disengagements can arise when pulling is applied on the winding material in a direction which is not "normal" ie not aligned with the shaded broad arrow in Fig 1B. Fig 1B illustrates that the divergences of the pulling from the "normal" direction can be in a vertical plane (making an angle α° with the horizontal plane) or can be in horizontal plane (making an angle β° with the vertical plane), or a combination of these two. Such divergences have the potential to cause mechanical damage to the material, and/or to reduce or stop the engagement with the guide (104).

[0041] Moreover, the conventional guides, such as the one illustrated in Fig 1A, comprise drums and guides broadly in the same horizontal plane, suitable for "peeling" the windable material from the drum (or rewinding it onto the drum) in a generally horizontal direction, as shown. Such systems are designed to work in the orientation illustrated in Fig 1A and are not suitable for re-orientation: if the Fig 1A arrangement were re-oriented through 90°, such that the guide is located vertically beneath (in the sense of Fig 1A) the drum, but the unwinding continued horizontally, or if removal/rewinding from/to the drum were to be in a vertical direction (in the sense of Fig 1A) the material be disengaged from the guide, would not be guided and the guide would not work.

[0042] Figs 2A and 2B show transverse and front views of a guided system, with drum (201) and guide (203), according to an embodiment of the invention, illustrating how the guide (203) cooperates with the drum (201). Fig 2A is partially a cross-section, showing the side of the drum (201) with the windable material (202) being fed off from the lower side of the drum (201) via a guide arrangement (203) shown generally on the left and Fig 2B shows the same arrangement but from a perspective which is perpendicular to that in Fig 2A. Fig 2A illustrates the windable material's passage between three pulleys (204, 205, 206) of the guide arrangement (203) after being peeled off from the windings on the drum (201). In the perspective illustrated in Figure 2B the guide arrangement (203) is now in the foreground, showing also a guide bar (207) of the guide arrangement (203) fixed to the drum (201), a guide carriage (208) mounted on the guide bar (207)

and housing pulleys (204, 205, 206), and, as in the Fig 2A, a portion of the windable material (202) passing between pulleys (204, 205, 206).

[0043] The orientation of the arrangement illustrated in Figs 2A and 2B is a first orientation. In the first orientation the windable material portion (202) is aligned horizontally as it is removed from the material windings on the drum (201). Fig 2A shows the two supports (209, 210) of the system (201, 203) which, in the first orientation illustrated in Figs 2A and 2B, are configured to serve as feet of the system (201, 203) supporting it on the ground or other flat surface. Two pins (209a, 210a) project perpendicularly from the supports (209, 210) and are configured to engage, in specified orientations of the system, with mounts (218), not shown in Figs 2A and 2B, as described later.

[0044] Movement of the windable material (202) can be achieved in two ways: by manually pulling the end of the windable material (202), the material will unwind, or peel away, from the drum (201), which consequentially rotates under the pulling force, or, alternatively, the drum (201) can be rotated by manual operation of the handle (211) which re-winds the windable material (202) onto the drum. These operations cause the outward or inward displacement of the windable material (202) through the guide arrangement (203) to/from the external environment.

[0045] Figs 3A and 3B illustrate the guide carriage (208) in more detail: Fig 3A is a cross-section of the guide carriage and Fig 3B is an external view of the guide carriage from the same perspective as Fig 3A.

[0046] Fig 3A shows a portion of the windable material (202) in the guide carriage (208), aligned horizontally, as at Figures 2A and 2B. The guide carriage (208) comprises a guide housing (212) which, according to an exemplary aspect of the arrangement herein disclosed, comprises a main pulley (204) and two auxiliary pulleys (205, 206). The three pulleys (204, 205, 206), in frictional contact with the portion of the windable material (202), are free to rotate due to the movement of the windable material (202) about their respective axes (204a, 205a, 206a), which are parallel to each other. The three axes (204a, 205a, 206a) of the three pulleys (204, 205, 206) are perpendicular to the axis of the portion (202) of the windable material. The three pulleys (204, 205, 206) are held in a positional relationship by a rigid housing (212) of the guide carriage (208), as shown at Fig 3B, such that the linear and angular separation between the main pulley (204) and two auxiliary pulleys (205, 206) is fixed. As the windable material portion (202) is moved longitudinally, in one (left or right in the sense of Fig 3A) of the X-directions indicated by the double-headed arrow, the windable material (202) engages on a first side (202a) of its surface (the upper surface in the perspective of Fig 3A) with the main pulley (204) and, simultaneously, engages on its second side (202b) of its surface (lower surface in the perspective of Fig 3A) with the two auxiliary pulleys (205, 206), causing all three pulleys (204, 205, 206) to rotate about their respective axes (204a, 205a, 206a).

[0047] Fig 3B depicts a housing (212) which is broadly shaped as an inverted and rounded V-shape, but it will be readily understood by the reader that the guide housing (212) can take any suitable form in which the spatial and angular separation of the three pulleys (204, 205, 206) is fixed and the spatial relationship between axes (204a, 205a, 206a) of the three pulleys (204, 205, 206) is maintained. While the rigidity of the guide housing (212) maintains the relative positional configuration of the three pulleys (204, 205, 206), the housing (212) is itself rotatable about an axis of rotation, as discussed later herein, meaning that the said spatial configuration is also rotatable.

[0048] Figs 4A and 4B which show a general perspective of the guide arrangement according to an embodiment of the invention, illustrating a guide carriage (208) and a guide bar (207): Fig 4A shows the guide arrangement loaded with the winding material (202) and Fig 4B shows the unloaded guide in the same perspective.

[0049] As shown in Figs 4A and 4B the guide bar (207) comprises a double threading (213), used in the prior art, as briefly described above. This double-threading (213), together with the rotary unit (not shown here) within the guide carriage (208) converts rotation of the main pulley (204) into lateral translation of the guide carriage (208), as briefly described previously, the rotary unit (not shown here) ensuring reversal of the direction of the lateral translation whenever the guide carriage (208) arrives at an end of the guide bar (207). Displacement of the winding material (202) in the X-direction, and consequential rotation of the main pulley in the Z-direction, causes, by means of the double-threading (213) on the guide bar (207), a corresponding displacement of the guide carriage in the Y-direction and, vice-versa, displacement of the guide carriage in the Y-direction causes a corresponding displacement of the windable material (202) in the X-direction.

[0050] As stated above, displacement of the windable material (202) in the X-direction can be achieved in different ways. An operator may pull the windable material away from the drum-guide arrangement (201, 203), or re-wind the material back on the drum (201), as appropriate, and thereby to determine its position in the X-direction. In accordance with an embodiment of the arrangement herein disclosed, the movement of the windable material (202) in the X-direction is unimpeded by the three pulleys (204, 205, 206), but, as explained above, the lateral position of the windable material (in the Y-direction), ie where it is located on the guide bar (207), is determined by the position of the guide carriage (208) on the guide bar (207): as the guide carriage (208) moves along the guide bar (207) it displaces the windable material portion (202) accordingly and vice-versa. In other words, displacement of the windable material (202) within the guide carriage (208), in an X-direction, causes the guide carriage (208), and also the portion of windable

material (202) contained within it, to be displaced, in a Z-direction, along the guide bar (207).

[0051] In view of the foregoing, the guide arrangement according to an embodiment of the invention herein disclosed, avoids a "bunching-up" of the windings at any particular part of the drum (201) and instead achieves an "even" distribution of the windings across on the drum (201).

[0052] In accordance with standard pulley designs, the reader will understand that the external circumferential surfaces of any of the three pulleys (204, 205, 206) may be concave in cross-section, in order to enhance engagement with the windable material (202). Although Figs 4A and 4B exhibit a concave surface (214) on the main pulley (204) with a cylindrical surface (215) on the auxiliary pulley (205), a mixture of concave surfaces (214) and cylindrical surfaces (215) may be used in any combination among the three pulleys (204, 205, 206) in various embodiments of the invention. The two auxiliary pulleys (205, 206) may be identical in form and size (as shown in the drawings), but are not limited thereto. In the case of cylindrical surfaces, a circular flange (216) may be present at the ends of the pulleys, to ensure correct guidance and passage of the surface of windable material (202) on the pulley. The curvature and "depth" of the concave surface (214) may be any suitable level to ensure good contact with the section of windable material (202) and may be a function of the diameter of the windable material (202): optionally, the depth may be equal to or greater than the diameter of the windable material (202). The surfaces of the pulleys (204, 205, 206) may also comprise ridges, bars or troughs (217) to increase frictional contact with the surface of the windable material (202). In the embodiment illustrated in Fig 4B the main pulley (204) exhibits these ridges (217), while the auxiliary pulley (205) is cylindrical in shape (with said flanges (216)).

[0053] The operation of the guide arrangement (203) according to an embodiment of the invention will now be explained in reference, firstly, to Figs 3A and 3B. As stated above, the main pulley (204) and the two auxiliary pulleys (205, 206) are in a predetermined spatial configuration: the linear and angular separation between the main pulley (204) and two auxiliary pulleys (205, 206) is fixed. The linear and angular separations will themselves vary as a function of the diameter of the winding material (202), but for any given diameter of winding material (202) the linear and angular separations will be fixed. In the arrangement shown in Figs 3A and 3B, the auxiliary pulleys (205, 206) engage with the lower surface of the windable material (202) (where "lower" is as viewed in the perspective of Figs 3A and 3B). The auxiliary pulleys (205, 206) are free to rotate in any direction about their respective axes and are not geared, or otherwise driven, by anything except the said lower surface of the winding material (202). The auxiliary pulleys (205, 206) serve to ensure optimal frictional contact between the upper surface of the windable material (202) and the main pulley (204) (where "upper" is as viewed in the perspective of Figs 3A and 3B). By means of the triangular configuration of the three pulleys (204, 205, 206) the auxiliary pulleys (205, 206) "cradle" the winding material (202) about the main pulley (204), as shown in Fig 3A. In accordance with this "cradling" function, the auxiliary pulleys (205, 206) force the windable material (202) into engagement with the main pulley (204), without impeding the longitudinal movement of the material (202).

[0054] By ensuring correct frictional contact between the windable material (202) and guide carriage (208), the three-pulley arrangement reduces slippage between the material (202) and the main pulley (204), thereby ensuring the guidance functionality of the guide, and therefore also correct (even) unwinding or rewinding of the material (202) from/on the drum (201), as referenced above, as well as the avoidance of kinks and other deformations. The cradling effect provided by three-pulley arrangement in the guide carriage (208) permits X-dimension translation of the windable material (202) but, within the guide carriage (208), limits translation movement of the material (202) in any direction perpendicular to the X-direction. In this sense, the three-pulley arrangement "traps" the windable material (202) within the guide carriage (208), thereby minimising the risk that the windable material "escapes" from the guide's control or that kinks or mechanical deformation will ensue.

[0055] As previously stated, the housing (212) of the guide carriage (208) is composed of a rigid material and serves to fix the linear and angular separations of the main and auxiliary pulleys (204, 205, 206) in the constant spatial configuration already referenced. The "cradle" effect, referenced above is therefore ensured by the guide carriage (208).

[0056] As stated above, the guide housing (212) is rotatable about an axis of rotation, which may be (but is not restricted to this) coincident with the rotational axis (204a) of the main pulley (204). In accordance with an embodiment of the invention, as shown in Figs 4A and 4B, the housing (212) may be pivotably mounted on the guide bar (207), such that the main pulley (204) *and* the housing (212) are both rotatable about the main pulley axis (204a) which is also the central longitudinal axis of the guide bar (207). Tthe guide housing (212) of the guide carriage (208) is a pivotably suspended from the guide bar (207), such that it is free to swing under the effect of gravity and its longitudinal axis (its axis of symmetry in Fig 3B) will always be aligned with the vertical (line AA in Fig 3B). The main pulley (204) is supported by the guide housing (212), and both are mounted on the guide bar (207), but the rotation of the main pulley (204) is separate and independent of the rotation of the housing (212). The rotation of the main pulley (204), as referenced above, is driven by any displacement of the windable material (202) and of the guide carriage (208), whereas any rotation of the housing (212), which is pivotably suspended on the bar guide (207), is determined by its own weight.

[0057] As the housing (212) of the guide carriage (203) is freely suspended from the guide bar (207) about which it pivots (Figs 4A and 4B), the orientation of the guide carriage (203) is self-adjusting. This self-adjustment may be considered analogous to a compass which always "finds North", as the housing (212) will always find, after a brief adjustment time lag, an equilibrium orientation in which it is "vertically" oriented. Regardless of the orientation of the guided system (the system comprising drum (201) and guide (203)), the alignment of the housing (212) will always be "vertical" in the sense that the two auxiliary pulleys (205, 206) will resume an equilibrium position (after a brief adjustment) in which they are symmetrically arranged about the vertical through the rotational axis (204a) of the housing (212), which is also the rotational axis of the main pulley. Consequently, alignment of the inverted V, mentioned previously in relation to Fig 3B, formed by the main pulley (204), at the top, and the two auxiliary pulleys (205, 206), at the bottom, will also be self-adjusting. The time lag for completion of the self-adjustment is likely to be short (less than one second) as the housing (212) is freely suspended from the guide bar (207) and will hardly be noticeable from the perspective of the user.

[0058] Figs 5A and 5B are schematics of an embodiment of the invention showing conceptually the three pulleys (204, 205, 206) comprised at fixed separations in the housing (212) of the guide carriage (203), the housing (212) being rotatably suspended about the axis of the guide bar (207). Fig 5A is a cross-section, while Fig 5B is a three-dimensional view. For clarity, the windable material is not shown in Fig 5B and the guide bar (207) is not shown in Figs 5A and 5B, which are provided herewith for explanatory purposes only: distances and angles are not shown to scale, and the shape of housing (212) is, in accordance with previous comments above, arbitrarily shown as rectangular, but it can be any suitable size or shape, such as the inverted V, as discussed previously. In relation to the self-adjusting orientation of the guide housing (212) the vertical (line AA), discussed above in respect of Figs 3A/B, and implicitly Figs 4A/B, is reproduced in Figs 5A/B. Fig 5A indicates the inner circumferences of the surfaces of the three pulleys (204, 205, 206), concave or cylindrical, in dotted lines (204b, 205b, 206b). In Fig 5A the section of windable material (202) (indicated by diagonal shading), although possibly circular in cross-section, is illustrated with an upper side (202a) and a lower side (202b). The material section (202) within the guide is illustrated as being substantially horizontal. Depending on the angular distribution of the two auxiliary pulleys (205, 206) about the vertical AA, the section may be forced into greater engagement with the main pulley (204) and may be slightly dihedral. It is envisaged that the upper side (202a) will engage with the main pulley (204) and the lower side (202b) will engage with the two auxiliary pulleys (205, 206). More precisely, the engagement will occur with inner circumferences (204b, 205b, 206b) of the surfaces of the three pulleys (204, 205, 206).

[0059] For the reasons set out above the circumferential surfaces of any of the pulleys may be concave, which further serves to ensure the "entrapment" of the section of windable material (202) within the guide carriage (208), as referenced briefly above. As stated previously, the "depth" of the concave surface may be sufficient to accommodate substantially the entire diameter of the windable material, as shown in relation to the main pulley (204) in Fig 5A, thereby ensuring that engagement is maximised and that guidance of the windable material is reliable. As shown in the embodiment of the invention in Fig 5A, the probability of the windable material being inadvertently pulled out from such a "deep" concave surface (204b) on the main pulley (204) is low, and is reduced further by the cradling effect of the auxiliary pulleys (205, 206), as described previously.

[0060] Fig 5B is a three-dimensional perspective of the arrangement in accordance with the invention as shown (in cross-section) in Fig 5A, and shows two planes: the first plane (205c) contains both the rotational axis (204a) of the main pulley (204) and the rotational axis (205a) of first auxiliary pulley (205), while the second plane (206c) contains both the rotational axis (204a) of the main pulley (204) and the rotational axis (206a) of second auxiliary pulley (206). For clarity's sake, the windable material (202) is omitted from Fig 5B. The two planes (205c, 206c) of Fig 5B intersect each other at the rotational axis (204a) of the main pulley (204), ie the rotational axis (204a) of the main pulley (204) is coincident with the intersection of the two planes (205c, 206c).

[0061] In Figs 5A and 5B, the dotted line AA represents the vertical which intersects axis (204a) of the centre of the main pulley (204). The angles θ_1 and θ_2 are the angular separations of the centres (in Fig 5A) of the two auxiliary pulleys (205, 206) from this vertical AA at the axis (204a). In Fig 5A the angle subtended by the two auxiliary pulleys (205, 206) at the axis (204a) of the main pulley is fixed and equal to the sum of angles $\theta_1+\theta_2$. Correspondingly, in the three-dimensional view in Fig 5B, the first plane (205c) forms an angle θ_1 with the vertical AA and the second plane (206c) forms an angle θ_1 with the vertical AA, such that the two planes (205c, 206c) are at an angle $\theta_1+\theta_2$ to each other. The axes of the auxiliary pulleys (205, 206)are equidistant the axis of rotation ((204a) in Fig 5A) of the guide housing (212), and marked as "d" in Fig 5A.

[0062] As stated above, the housing (212) is rotatable. In the embodiment shown in Figs 5A and 5B the rotational axis of the housing (212) is the axis (204a) of the main pulley (204), but rotation of the housing (212) is not limited to rotation about the main pulley's axis (204a) and other axes of rotation of the housing (212) are also envisaged within the invention.

[0063] In the embodiment of the invention illustrated in Figs 5A and 5B, as the housing (212) is free to rotate about the axis (204) of the main pulley (204), coaxial with the axis of the guide bar (207), θ_1 and θ_2 are free to vary, but the sum of θ_1 and θ_2 will remain fixed, as the housing

(212) is a rigid construction. Under the influence of gravity, the housing (212) will (after a momentary delay, as described above) find an equilibrium position in which the line bisecting the angle subtended by the two main pulleys will coincide with the vertical AA, such that θ_1 will equal θ_2.

[0064] The reader will understand that the rigid housing (212) not only guarantees the fixed linear and angular separation of the three pulleys (204, 205, 206) with respect to each other, but also guarantees that the orientation of the triangle formed by the three pulleys (204, 205, 206) is maintained: whatever the orientation of the drum-guide system (201, 203), the two auxiliary pulleys (205, 206) will be subtend the same angle at the axis of the main pulley (204) to the vertical AA. In Fig 5A and 5B, the guide will always adjust itself to an equilibrium such that θ_1 equals θ_2.

[0065] The main pulley (204) and the two auxiliary pulleys (205, 206) form a triangle (204, 205, 206) which is suspended about the axis (204a) of the main pulley (204) and rotatably displaceable about that axis (204a). The reader will understand that under the weight of the housing (212) and pulleys (204, 205, 206) housed therein, this "hanging triangle" will adjust itself from any angular perturbation and find its equilibrium in which the two auxiliary pulleys (205, 206) are symmetrically arranged about the vertical AA through the axis of main pulley (204). Consequently, the section of windable material (202) in the guide (203) will also be brought into an equilibrium horizontal orientation.

[0066] The reader will understand that the three-pulley arrangement according to an embodiment of the invention disclosed herein combines the angular self-adjustment, described above, with the enhanced "entrapment" of the windable material. As explained in the next section, the three-pulley arrangement constantly self-adjusts to hold (to guide) the section of windable material (202) in a horizontal orientation, but also eliminates the risk that the material (202) is disengaged from the guide (203). The result is that the windable material (202) may be pulled in a non-aligned direction (eg by an inadvertent tug in a lateral direction), as described above, without risk of disengagement or mechanical deformation.

[0067] Figs 6A and 6B illustrate an aspect of the operation of the three-pulley arrangement according to an embodiment of the invention and the "entrapment" discussed above in combination with the self-orientation aspect. Referring again to the technical shortcomings of conventional guides (described previously in relation to Fig 1B), if the user were to inadvertently pull the windable material (202) in a direction other than the "normal" outward direction (as described previously), ie at an angle $\alpha°$ from the horizontal plane (marked by a dotted line in Fig 6A) or at an angle $\beta°$ from the vertical plane (marked by a dotted line in Fig 6B), or a combination of these two, the three-pulley arrangement provided in an embodiment of the guide (203) disclosed herein, will ensure that the section of windable material (202) will remain within the guide (203). Figs 6A and 6B demonstrate the ability of the guide according to an embodiment of the invention to retain the windable material and prevent kinks, entanglement or mechanical deformation due to pulling at divergent angles. Unlike conventional arrangements, in the arrangement according to an embodiment of the invention, the windable material (202) is *held* between the main pulley (204) above it and the two auxiliary pulleys (205, 206) below it, and, irrespective of the angle ($\alpha°$, $\beta°$) in which it is pulled, the three-pulley arrangement will prevent the windable material from "escaping" from the guide. The presents clear benefits for the user, who can pull the material in a wider range of angles without the risk of disengagement from the guide, or entanglement or mechanical damage of the material.

[0068] The self-adjustment explained herein has important consequences on the guidance functionality of the guide. By means of the guide arrangement (203) as disclosed herein, the orientation of the drum-guide system (201, 203) is irrelevant to guide functionality: the guide arrangement (203) will serve to guide the windable material (202) irrespective of the orientation of the drum-guide combination (201, 203). Unlike conventional guides, which only function for one specific orientation of the drum-guide combination (201, 203) the guide arrangement of the invention will operate in any such orientation.

[0069] The versality of the arrangement is demonstrated by Figs 7A and 7B which illustrates an embodiment according to the invention. Figs 7A and 7B illustrate the same arrangement as shown in Figs 2A and 2B, but with the arrangement in a different orientation. In Figs 2A and 2B the supports (209, 210) are at the bottom of the drawings and act as feet for the drum-guide system (201, 203) on the floor or other horizontal surface. In Figs 7A and 7B the same system (201, 203) has been turned through 90°, into a second orientation, such that the two supports (209, 210) are now visible on the right of Fig 7A for mounting on a wall or other vertical surface, by means of the pins (209a, 210a) which are configured to engage, in the second orientation, with corresponding slots in the wall mountings (218) which are fixed to a wall (219) or other vertical or near vertical surface. The drum-guide system (201, 203) can, in this way, be mounted on a wall or other vertical surface, according to the wishes of the user, who is not therefore not obliged to simply stand the drum-guide system (201, 203) on a horizontal surface.

[0070] Although the orientation of the system (201, 203) in Figs 2A/2B and Figs 7A/7B is different, the orientation of the guide (203) remains unchanged, because of the self-adjusting orientation of the housing (212) (and guide (203)), as described above. With respect to the main pulley, the two auxiliary pulleys have not moved and the angular orientation of the guide (203) is the same in both Figs 2A/2B and Figs 7A/7B: the guide is vertically aligned in both situations. Even though the windable material (202) now (in Fig 7A) enters the guide vertically (202b) the portion engaged between the three pulleys

(204, 205, 206) is still horizontal, such that the guidance function of the guide (203) is the same in both system orientations. By contrast, systems with conventional guides function in just one single system orientation.

[0071] Rotating the guide system (201,203) between the two different orientations (those depicted in Figs 2A/2B and Figs 7A/7B respectively) has no effect on the functioning of the guide (203), the guide (203) working equally well in both orientations. This means the guided system (201, 203) according to an embodiment of the invention can be used in both free standing (floor) and wall mounted positions. The reader will appreciate that this is the case of any system orientation intermediate to those shown in Figs 2A/2B and Figs 7A/7B.

[0072] Moreover, although not illustrated here, it will be understood that the self-adjusting nature of the guide (203) according to an embodiment of the invention will work equally well on ceiling-mounted systems, because the rotatable guide according to an embodiment of the invention will always adopt a vertically suspended angular position. The configuration provided by the inverted-V (or any other suitable shape) discussed previously, as provided by the rigid housing (212) will always rotate about the axis of the main pulley such that the two auxiliary pulleys (205, 206) are arranged equally about the vertical through the axis of the main pulley (204) (see reference above to "hanging triangle"). The angles (θ_1 and θ_2 in Fig 5) subtended by the two auxiliary pulleys (205,206), or the corresponding planes (205c, 206c) at the main pulley axis (204a) will always adjust to be the same. In short, it will be readily understood that the self-adjustment of the guide (203) occurs in all orientations of the drum-guide system (201, 203).

[0073] Further to the description above of the frictional engagement of the windable material with the three pulleys, it will be readily understood by the reader that correct engagement requires suitable dimensioning of the housing and, in particular, careful selection of the distance between axes of the main pulley (204) and the auxiliary pulleys (205, 206), marked "*d*" in Fig 5A. As explained above, the section of windable material (eg a hose) passes between the main pulley (204) and the auxiliary pulleys (205, 206): if distance d is too large the auxiliary pulleys (205, 206) will not force the windable material into engagement with the main pulley (204), but if distance *d* is too small, such that the gap between the main and auxiliary pulleys is too narrow, the passage of the section of windable material (202) will be impeded or prevented, or, in a worse case scenario, the windable material (202) could suffer mechanical damage. The correct size of the gap and the correct value of the distance *d* is dependent on the width of the hose or other windable material: a wider hose will require a larger *d* value, while a narrower hose will need a lower *d* value. The values of θ_1 and θ_2 may also be varied to increase or reduce the engagement of the pulleys: if the values of θ_1 and θ_2 are small, such that the two auxiliary pulleys (205, 206) are closer, the engagement, for any given hose diameter and any given value of *d,* may be correspondingly lower, whereas larger values of θ_1 and θ_2 may, mutatis mutandis, cause an increased engagement.

[0074] It will be self-evident that the relative positions of the pulleys and their linear and angular separations must be suitable to provide an appropriate degree of engagement with the section of windable material and that any suitable values may be adopted in order to achieve this. As the reader will understand a range of separations and linear/angular separations may be suitable to achieve an appropriate degree of engagement.

[0075] As stated previously, the rigid housing (212) serves to *fix* the spatial relationship between the three pulleys (204, 205, 206) in which the degree of engagement is considered suitable, such that the configuration is then invariant (although the housing (212) is itself rotatable), as discussed herein.

[0076] Finally, the relative location of the guide (203), comprising the guide bar (207) and guide carriage (208), in respect to the drum (201) also plays a role in determining the quality of the engagement. It is envisaged that the relative location of guide and drum be fixed.

[0077] The concepts and innovations disclosed herein may be applied to any type and any size of windable material or any size of hose, although the linear and angular separations of the pulleys may have to be scaled up or reduced accordingly.

[0078] For a standard hose pipe of diameter 12.5mm, it is envisaged that an optimal engagement occurs when the angle subtended by the two auxiliary pulleys (205, 206) at the axis of the main pulley (204) ie the sum of θ_1 and θ_2, equals 70°. It is further envisaged that (in the perspective of Fig 2) the centre of the guide (203), ie the axis of the guide bar (207) is in the same horizontal plane as the outermost coil of the hose windings on the drum (201) when the hose is in a fully wound state in a first orientation.

[0079] Although this disclosure makes reference to several examples of the aspects and embodiments, it will be readily understood that embodiments of the invention are not restricted to those which are explicitly referenced herein: all aspects and embodiments may be modified to comprise any number of amendments, alterations, variations or substitutions, including those which may not be explicitly referenced herein. Accordingly, the embodiments of the invention are not to be understood as limited by the written description set out herein and are to be limited only by the scope of the appended claims. Although some features of some embodiments appear in some examples, embodiments or drawings and not in others, this is only for brevity and intelligibility: components, features and structures of the aspects and embodiments disclosed herein may be readily combined as appropriate. Even if such combinations are not illustrated or explicitly referenced herein in relation to a particular aspect of an embodiment this is merely for brevity of the description and should not be interpreted as meaning that such combinations are excluded or impossible: the

different features and of the various aspects and embodiments may be mixed and combined as appropriate and this disclosure should be construed as covering all combinations and permutations of features referenced herein.

Claims

1. A guide for guiding an elongate windable material from/to a drum, the guide comprising a guide housing for containing a displaceable section of the winding material and configured to maintain a rotatable main pulley and two rotatable auxiliary pulleys in a fixed spatial relationship with each other, wherein

   - the axes of the pulleys are parallel to each other and perpendicular to the longitudinal axis of the section of windable material contained in the housing,
   - the main pulley is configured to engage with a first side of the material section, and
   - the auxiliary pulleys are configured to engage with a second side of the displaceable material section opposite the first side of the material section.

2. A guide as in Claim 1 wherein the guide housing is freely rotatable about an axis parallel to the axes of the pulleys.

3. A guide as in Claim 2, wherein the guide housing is rotatable about the axis of the main pulley.

4. A guide as in Claim 2 or 3, wherein the rotation of main pulley is independent of the rotation of the guide housing.

5. A guide as in any preceding claim, wherein the rotational axes of the two auxiliary pulleys are equidistant from the rotational axis of the guide housing.

6. A guide as in any of Claims 3 to 5, wherein a first plane contains the rotational axis of the main pulley and one of the auxiliary pulleys and a second plane contains the rotational axis of the main pulley and the other of the auxiliary pulleys, wherein the first and the second plane intersect at the rotational axis of the main pulley and the angle between the first and the second plane at their intersection is fixed.

7. A guide as in Claim 6, wherein the angle between the first plane and the second plane is 70°.

8. A guide as in any preceding claim wherein the two auxiliary pulleys are configured to constrain the material section into engagement with the main pulley.

9. A guide as any of Claims 2 to 8 wherein the rotatable guide housing is configured to automatically adjust its orientation and, wherein, after the self-adjustment, the auxiliary pulleys are symmetrically disposed about a vertical through the main pulley.

10. A guide as in any preceding claim, further comprising a guide carriage displaceably mounted on a guide bar, wherein the guide carriage comprises the guide housing as in any preceding claim.

11. A guide as in Claim 10, wherein the displacement of the guide carriage along the guide bar is a function of the longitudinal displacement of the windable material in the guide

12. A guide as in Claim 10 or 11, wherein the rotational axis of the guide housing is the longitudinal axis of the guide bar.

13. A guide as in any preceding claim wherein the elongate windable material is a hose for horticulture, gardening, irrigation or watering.

14. A system comprising a drum for storing windings of windable material and a guide as in any preceding claim, wherein the guide is attached to the drum and is configured to guide the windable material as it is unwound/rewound from/to the windings stored on the drum.

15. A method for guiding an elongate windable material from/to a drum comprising the steps of:

    maintaining, in a guide housing for containing a displaceable section of the winding material, a rotatable main pulley and two rotatable auxiliary pulleys in a fixed spatial relationship with each other, and
    configuring

    - the axes of the pulleys parallel to each other and perpendicular to the longitudinal axis of the section of windable material contained in the housing,
    - the main pulley to engage with a first side of the material section, and
    - the auxiliary pulleys to engage with a second side of the displaceable material section opposite the first side of the material section.

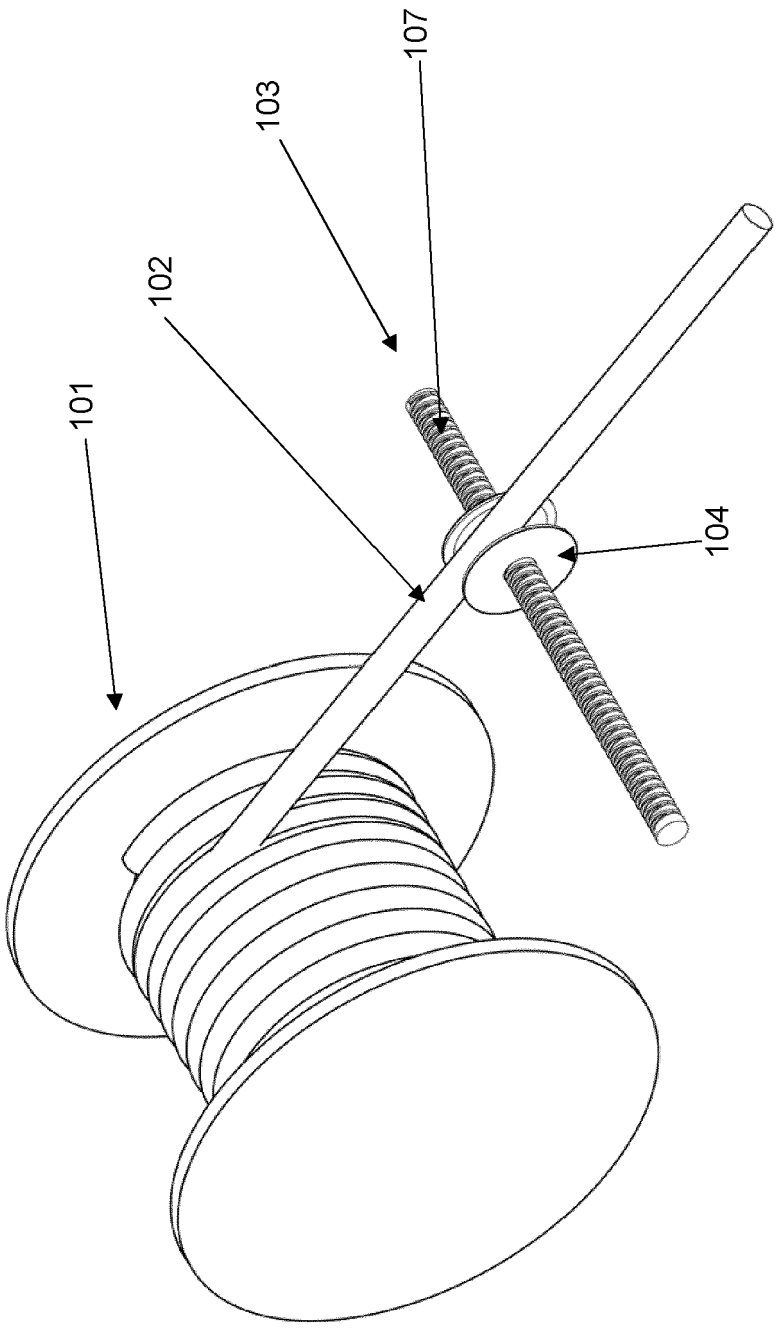

Figure 1A

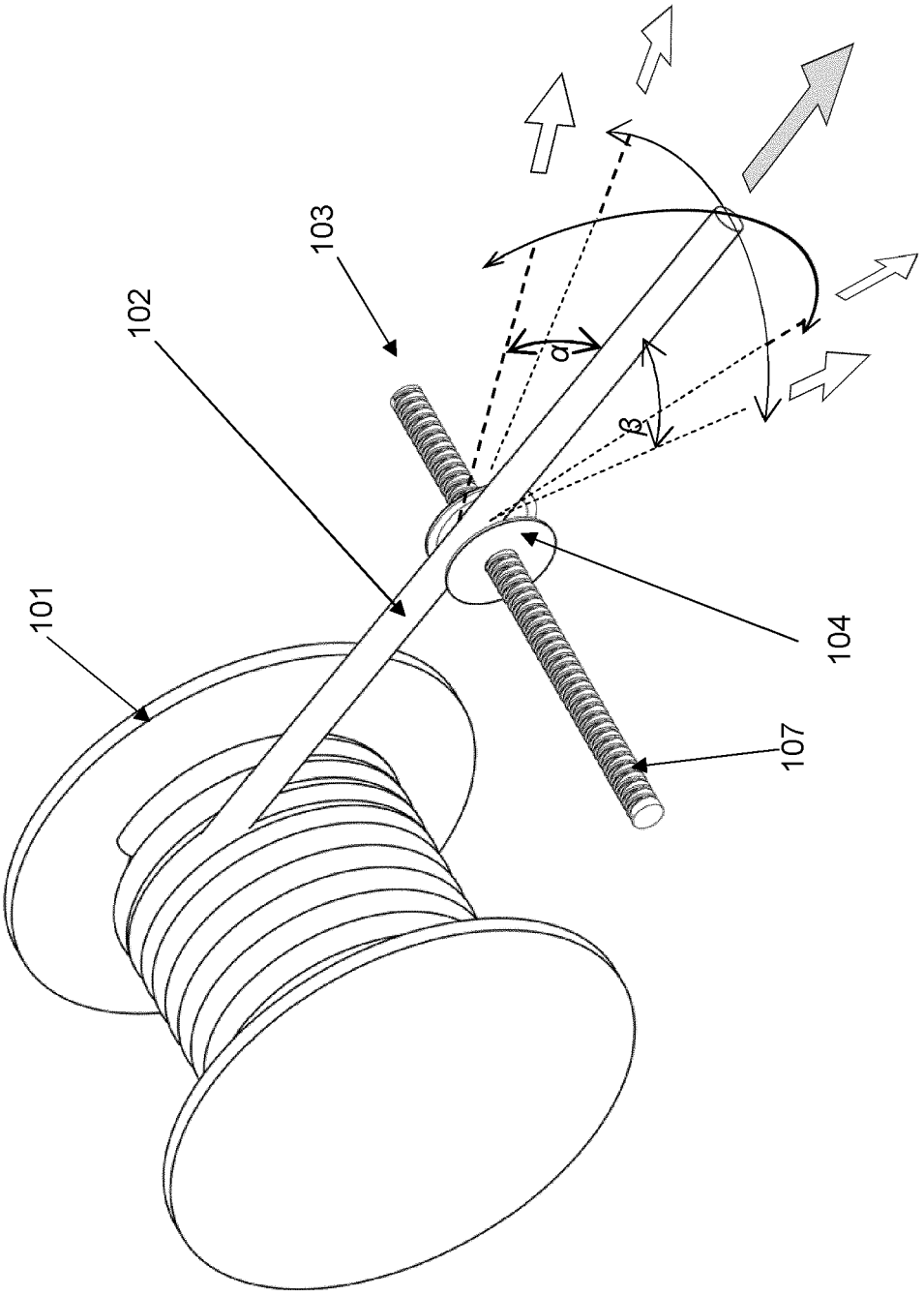

Figure 1B

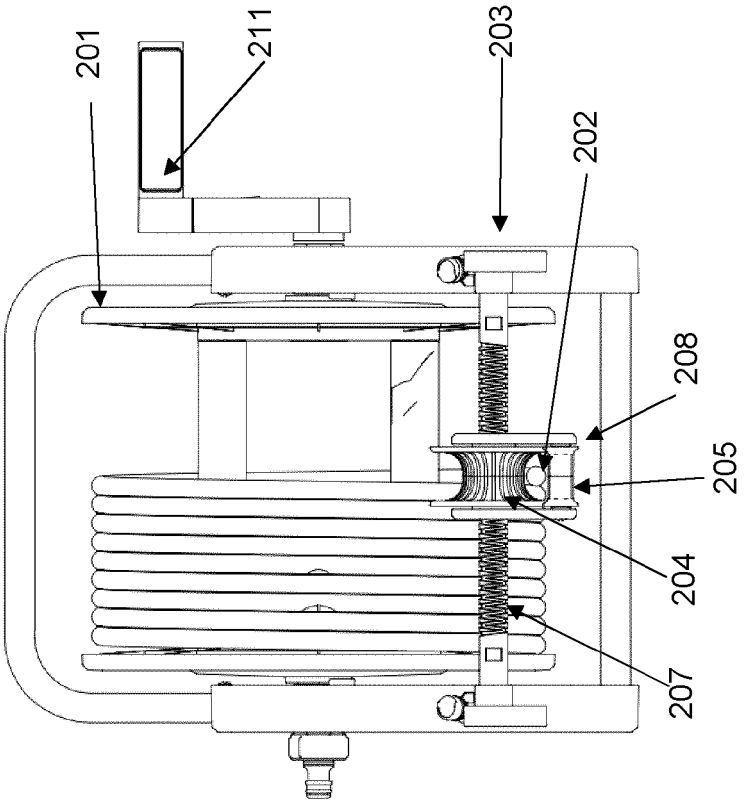

Figure 2B

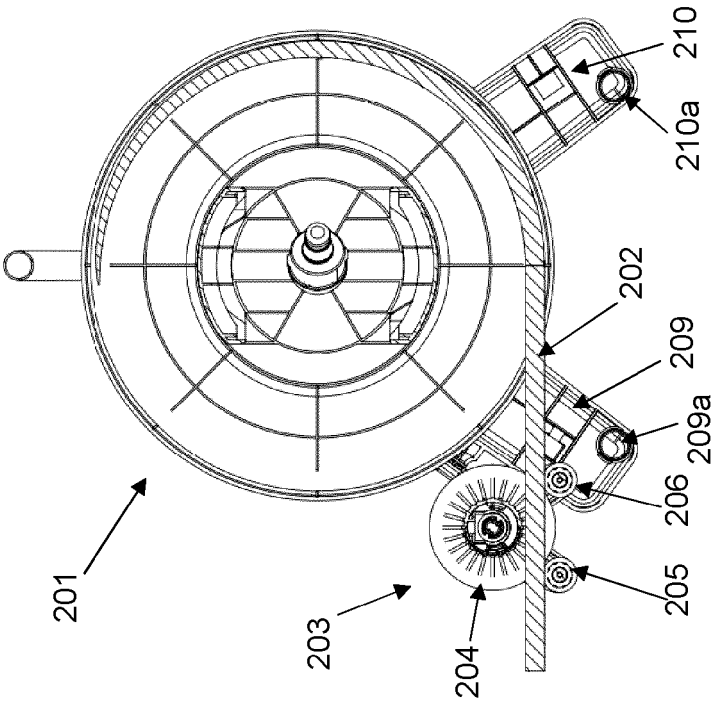

Figure 2A

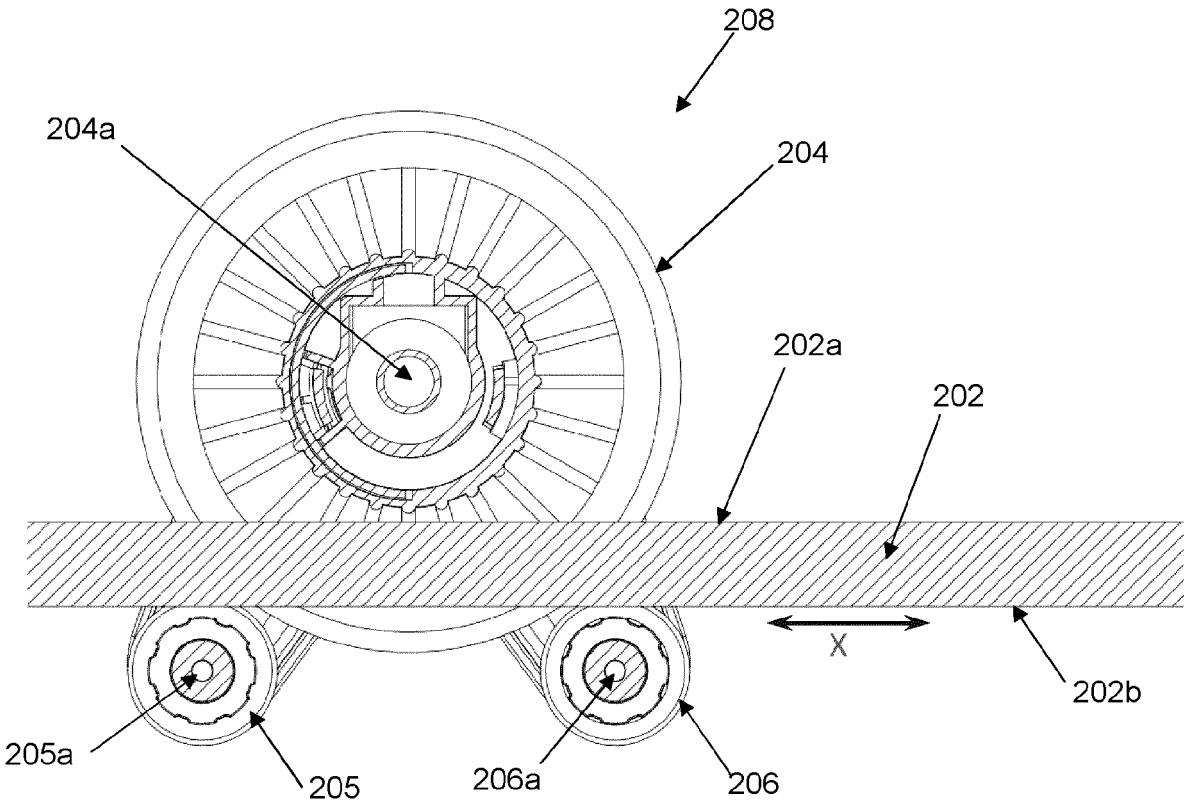

Figure 3A

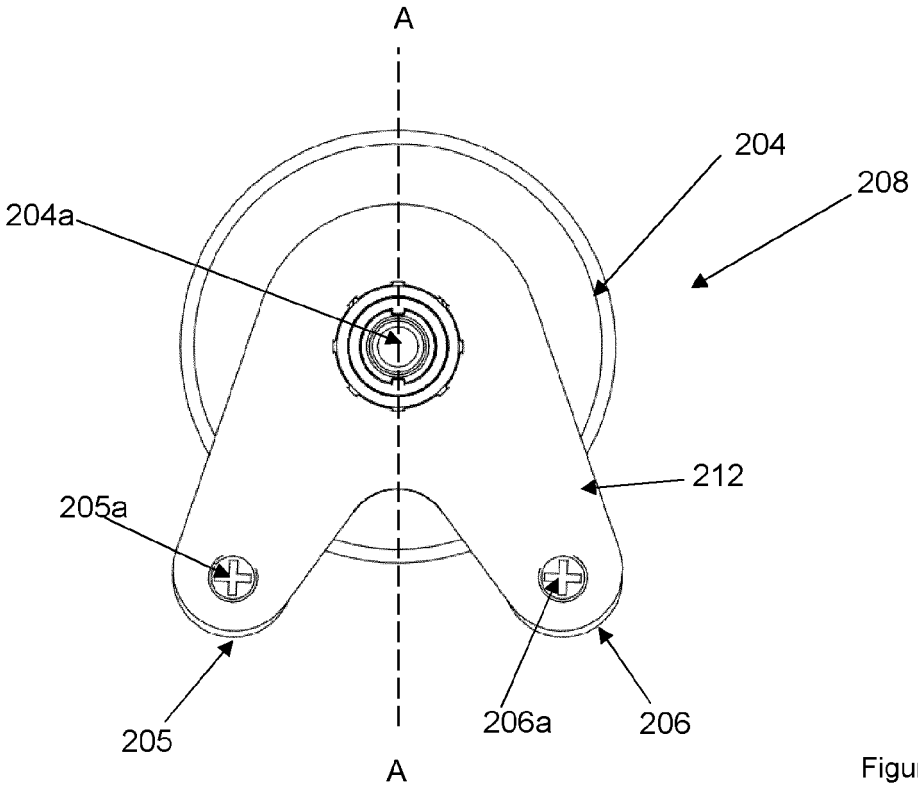

Figure 3B

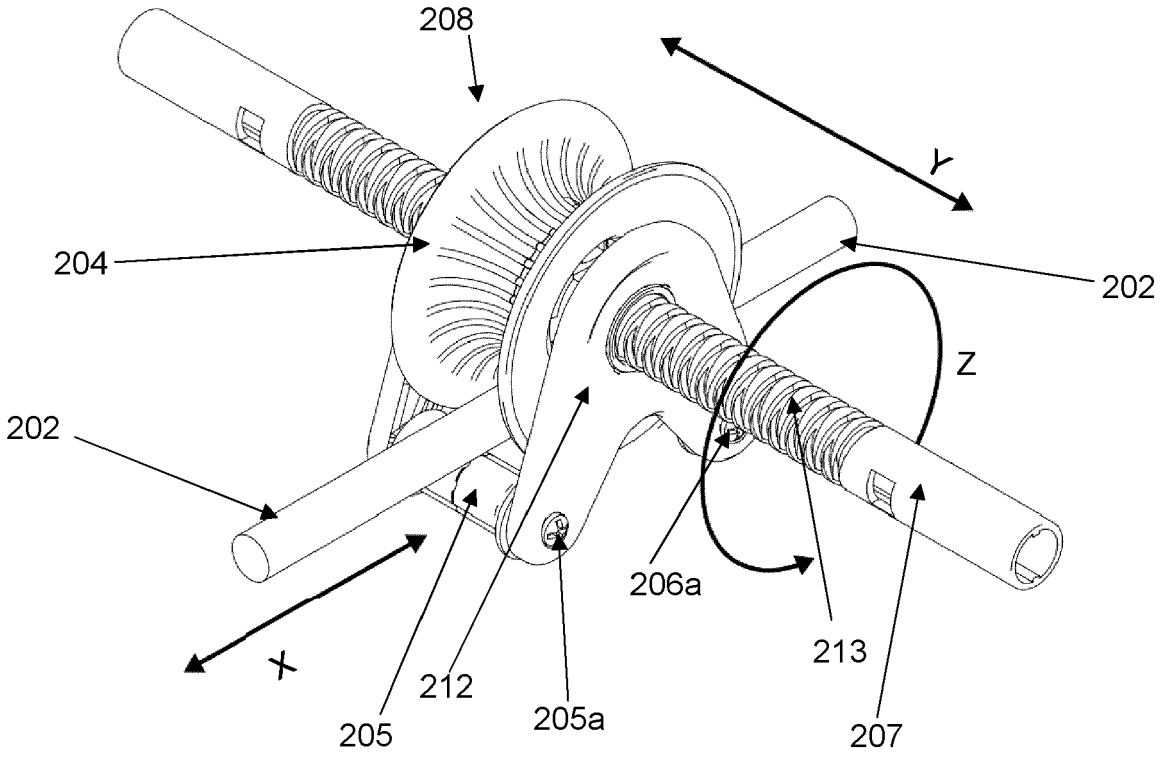

Figure 4A

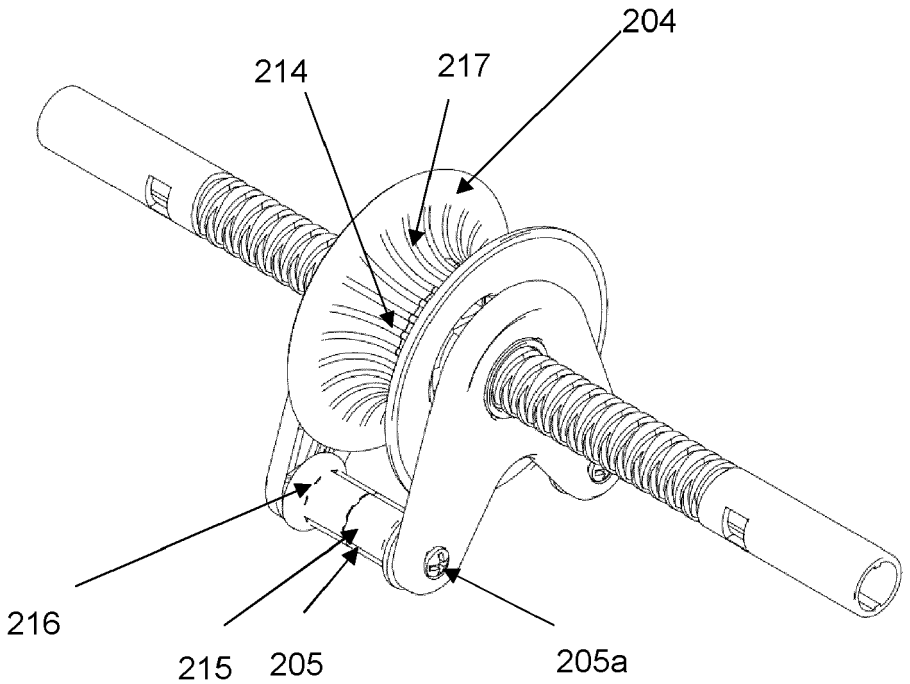

Figure 4B

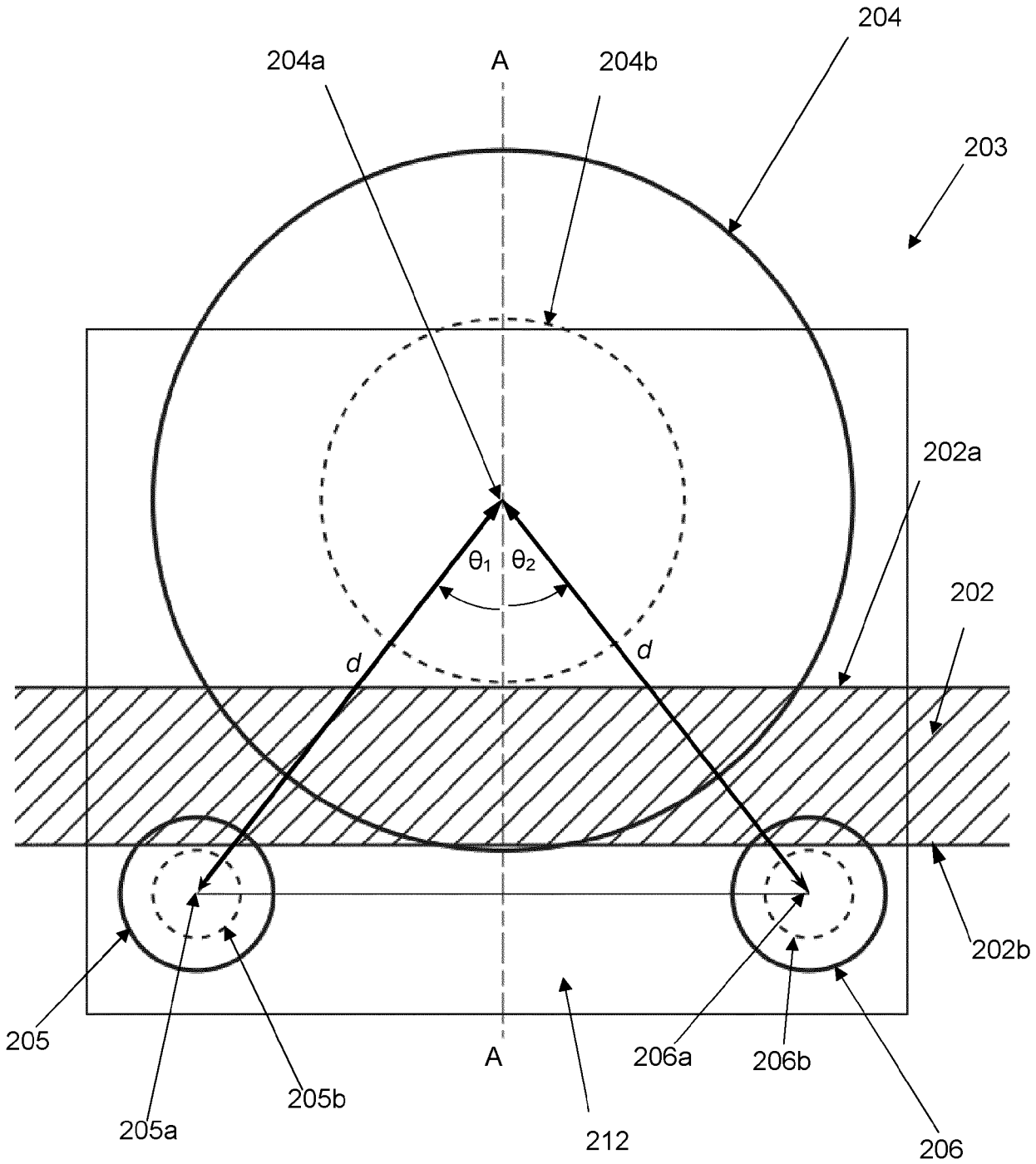
204
204a
A
204b
203
202a
θ1
θ2
202
d
d
202b
205
A
206a
206b
205b
205a
212
206

Figure 5A

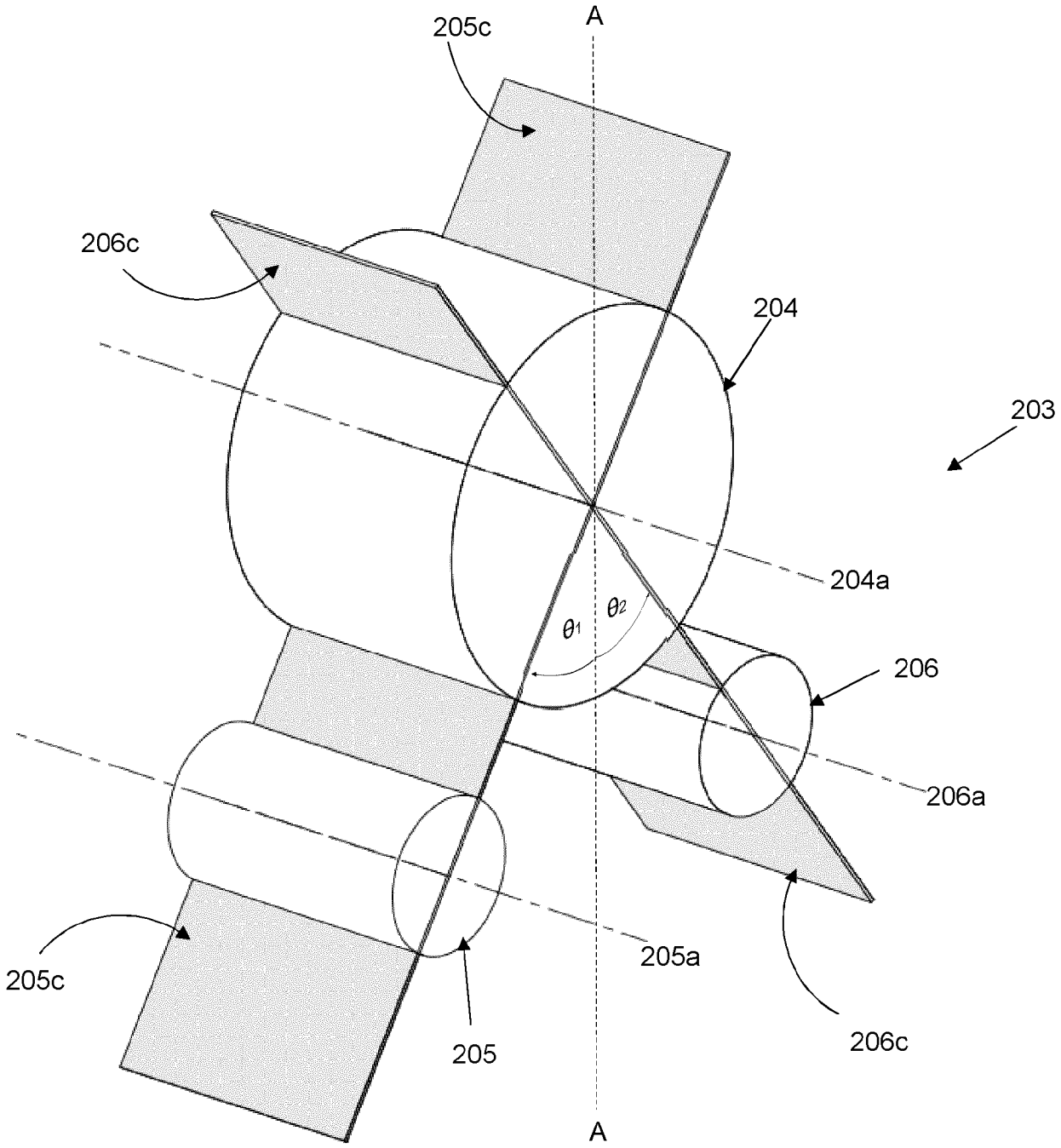

Figure 5B

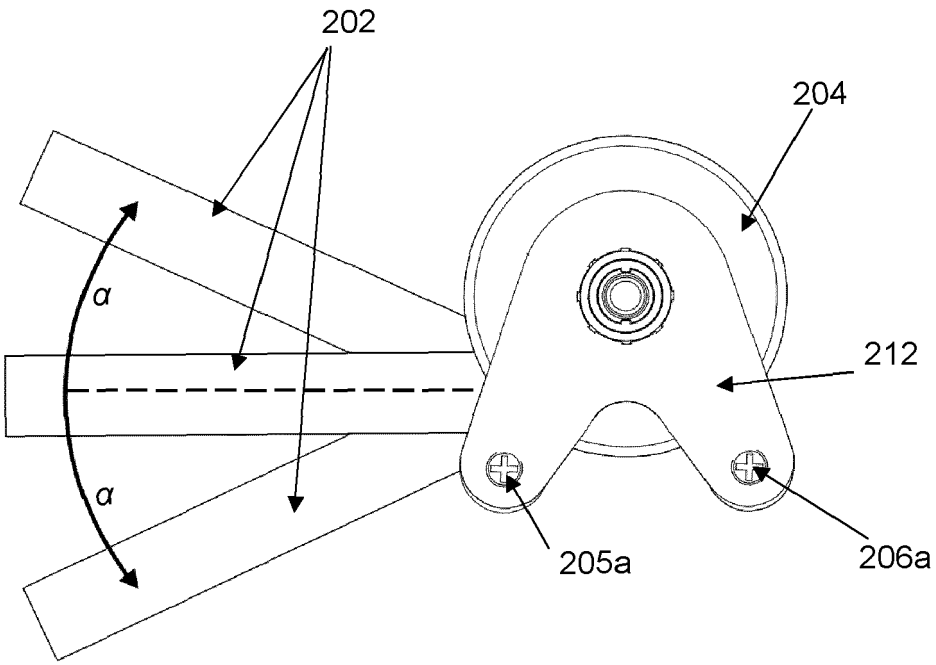

Figure 6A

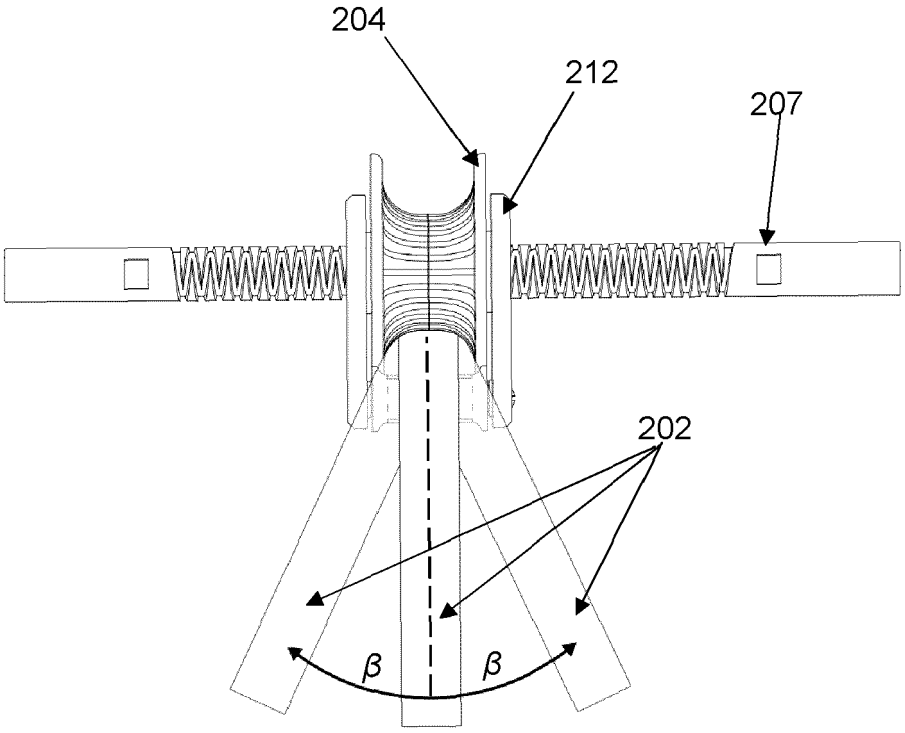

Figure 6B

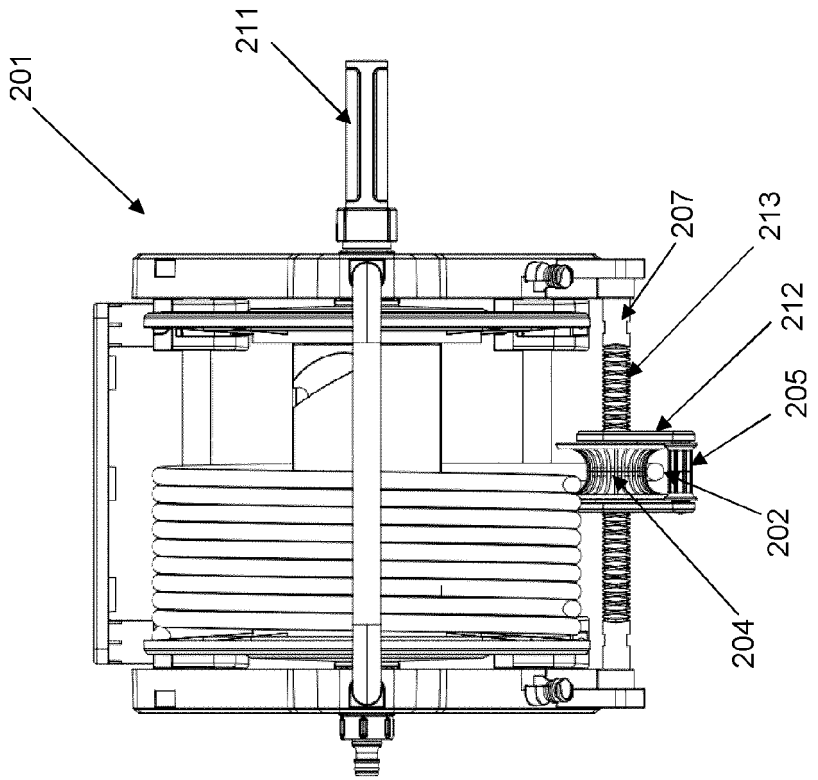

Figure 7B

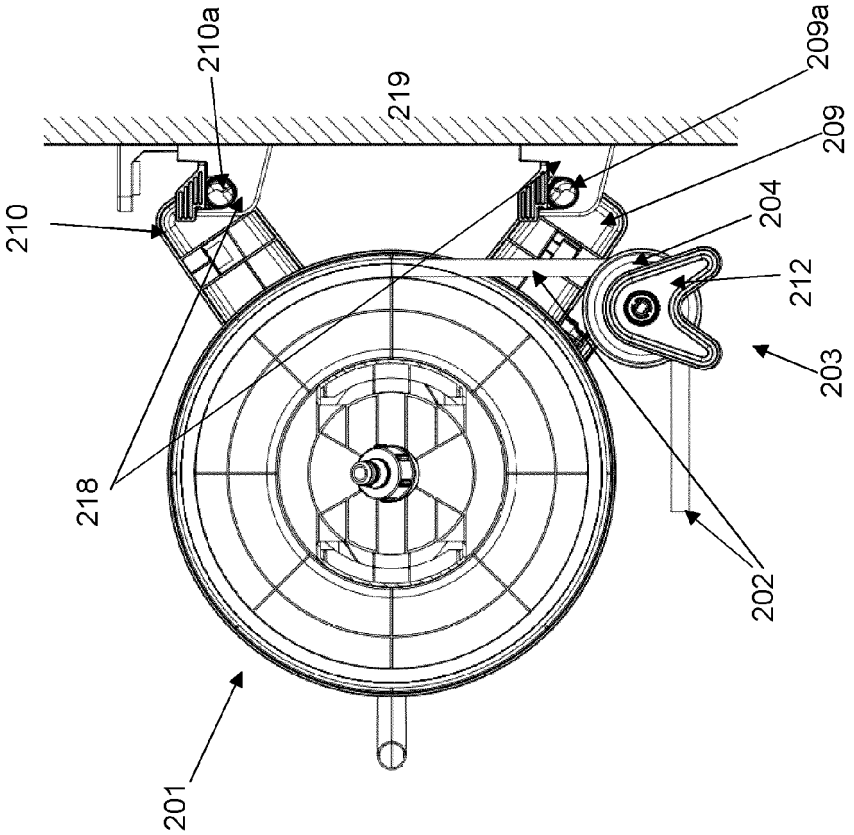

Figure 7A

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 8634

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 May 2022	Lemmen, René

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