(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 282 799 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.11.2023 Bulletin 2023/48

(21) Application number: **22212069.3**

(22) Date of filing: **07.12.2022**

(51) International Patent Classification (IPC):
B65H 57/00 *(2006.01)* ***B65H 75/44*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B65H 75/4405; B65H 57/006; B65H 2701/33

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) GUIDE OR FEEDER SYSTEM AND SUSPENSION SYSTEM FOR A WINDABLE MATERIAL

(57) A guide (203, 303) for guiding an elongate windable material (302) from/to a drum, the guide comprising a guide bar (207, 307) on which a pulley (204, 304) is mounted. The guide also comprises at least one spring (205, 305) which is configured to rotatably mount the pulley on the guide bar. The guide may comprise a guide frame (314) for containing a displaceable section of the winding material and configured to maintain a rotatable main pulley (304) and at least one rotatable auxiliary pulley (312, 313) in a spatial relationship with each other, wherein at least one of the pulleys is mounted on a spring (305). The axes of the pulleys are parallel to each other and perpendicular to the longitudinal axis of the section of the windable material contained in the housing. The windable material is displaceable between the main pulley and the two auxiliary pulleys, the main pulley and the auxiliary pulleys engaging respectively with a first surface (302a) of the windable material and a second surface (302b) of the windable material, the second surface being opposite the first surface.

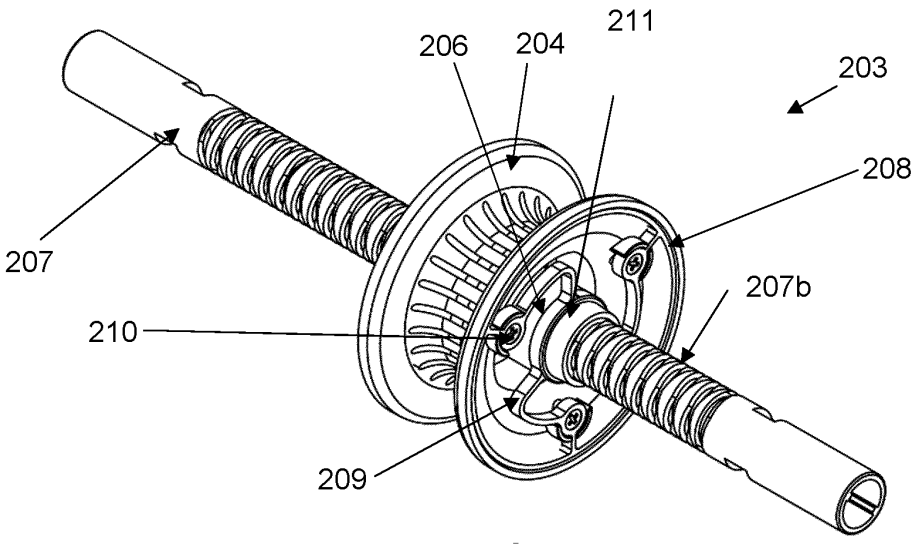

Fig 2C

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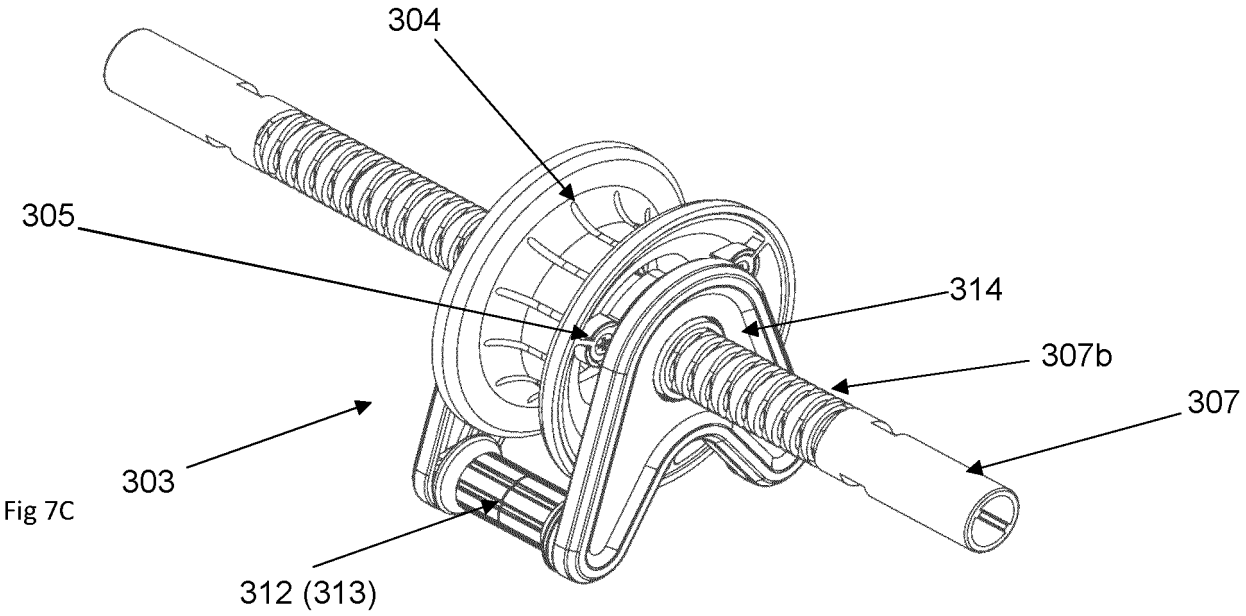


Fig 7C

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, of any diameter, 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

"guide(s)" or "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 is 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 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 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 as the guide moves up/down the bar.

[0012] However, conventional guides suffer from a number of shortcomings. One notable technical disadvantage of conventional guides is that they are each designed to accommodate hoses or windable material of a pre-determined diameter and unable therefore to wind/unwind windable material other than this specific diameter.

[0013] A further problem associated with conventional guides is that the angular position of the guide with respect to the drum is fixed. The engagement of the guide with the hose or windable material being wound/unwound may be discontinuous. In actions where the pulling force on the windable material is excessive, especially where such force is applied laterally, to the extent that the windable material is forced, even momentarily, out of alignment with the drum, the engagement with the drum may be lost. 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.

[0014] 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

[0015] It is an objective of the arrangement and method herein disclosed to overcome the shortcomings of prior art apparatuses and methods indicated above.

[0016] An objective of the arrangement and method of the current disclosure is to provide a guide for guided system which is flexible and not specific to any particular hose or windable material with a single pre-determined diameter and will accommodate a range of different diameters, rather just one.

[0017] It is a further objective of the arrangement and method disclosed herein to provide a guide for a guided system which minimises disengagement of the windable material from the guide, thereby automatically and continuously minimising 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

[0018] 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.

[0019] The inventive arrangement and method disclosed herein minimises user monitoring and user intervention.

STATEMENT OF THE INVENTION

[0020] This disclosure relates to a novel and inventive apparatus and method for guiding and feeding a windable material from or to a drum.

[0021] An exemplary aspect of the apparatus herein disclosed is directed to a guide for guiding an elongate windable material from/to a drum, the guide comprising a guide bar with a longitudinal axis, a first pulley for rotation coaxial with, or about an axis parallel to, the longitudinal axis of the guide bar, parallel to the axis of the drum, the first pulley being configured to engage with a

section of the elongate windable material, and at least one flexible spring for rotatably mounting the first pulley on the guide bar.

[0022] In an embodiment according to the invention the at least one spring is configured to, in an unflexed state, rotatably support the first pulley for rotation coaxially with the longitudinal axis of the guide bar, and, in a flexed state, rotatably support transverse displacements of the first pulley, wherein the axis of rotation of the first pulley is parallel to, but displaced from, the longitudinal axis of the guide bar.

[0023] In an exemplary aspect of the arrangement herein disclosed the at least one spring comprises an inner portion mounted rotatably on the guide bar and an outer perimeter portion attached to the first pulley, the outer perimeter portion being mounted on the inner portion by a plurality of flexure arms, the flexure arm(s) being non-linear and extending radially from the inner portion and configured to flex and to rotate the outer perimeter portion with rotations of the inner portion, and vice versa.

[0024] An embodiment of the invention herein comprises the flexure arms configured to, when in a flexed state, support transverse displacements of the outer perimeter.

[0025] In an embodiment of the invention the inner portion and outer perimeter portion of the at least one spring are generally circular or cylindrical in geometry, and respectively form an inner ring/cylinder and outer ring/cylinder, these being rotatable about an axis parallel to the longitudinal axis of the guide bar.

[0026] In an aspect of the invention herein disclosed the guide bar comprises a double helix configured to longitudinally displace the guide along the guide as a function of the rotation of the inner ring spring.

[0027] In an embodiment according to the invention, the at least one spring comprises two springs, one on each flank of the first pulley.

[0028] In an aspect of the invention the at least one spring comprises one single spring located within the first pulley in the main plane of first pulley.

[0029] In an embodiment of the arrangement herein disclosed the guide comprises a guide frame for receiving a displaceable section of the windable material, the guide fame being mounted rotatably on the guide bar and being configured to rotatably mount the first pulley and at least one rotatable auxiliary pulley, the auxiliary pulley(s) being aligned in parallel with the first pulley.

[0030] According to an embodiment of the invention the main pulley is configured to engage with a first side of the displaceable section of the windable material, and the auxiliary pulley(s) is/are configured to engage with a second side of the displaceable material section opposite the first side of the material section.

[0031] In accordance with an embodiment of the invention the guide frame is freely rotatable about an axis parallel to the longitudinal axis of the guide bar.

[0032] In an aspect of the invention the rotational axes of the two auxiliary pulleys are equidistant from the rotational axis of the guide frame.

[0033] According to an embodiment of the arrangement herein disclosed the elongate windable material is a hose for horticulture, gardening, irrigation or watering.

[0034] In an aspect of the invention there is a system comprising a drum for storing windings of windable material and a guide as previously described, 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.

[0035] An embodiment of the invention is directed to a method for guiding an elongate windable material from/to a drum comprising the steps of: providing a guide comprising a guide bar with a longitudinal axis, and a first pulley for rotation coaxial with, or about an axis parallel to, the longitudinal axis of the guide bar, parallel to the axis of the drum; rotatably mounting the first pulley on the guide bar by means of at least one flexible spring; and engaging the first pulley with a section of the elongate windable material

BRIEF DESCRIPTION OF THE FIGURES

[0036] 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, 2B and 2C are side, cross-sectional and perspective views of an embodiment of a guided system according to an embodiment of the invention. Figure 2A additionally illustrates three planes (AA, BB and CC) referenced hereinafter, The two cross-sections provided in Figure 2B correspond to the planes AA and BB/CC respectively. Fig 2D shows a spring according to various embodiments of the invention.

Figures 3A and 3B are cross-sections of a spring according to an embodiment of the invention;

Figure 4 is an exploded view of an embodiment of a guide system according to the invention;

Figures 5A and 5B are drawings of an embodiment of a spring-mounted guide according to the invention, loaded with a portion of windable material;

Figures 6A and 6B are side (partly cross-sectional) and top views of a reel and guide system in accordance with an embodiment of the invention, with the windable material being pulled in different angles.;

Figures 7A, 7B and 7C are illustrations of an embodiment of a guided system according to the invention: Figure 7A is a cross-section in plane AA as Fig 2A; Figure 7B is a cross-section in plane CC (or alterna-

tively in plane BB); and Figure 7C is a perspective view.

Figure 8 is a schematic drawing of multi-pulley guide according to an embodiment of the invention.

[0037] 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

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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 (103). The guide (103) comprises a pulley (104) 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 pulley (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 in Fig 1A) within the pulley (104) is forced into rotation by the displacement of the hose or other windable material in the pulley (104) and cooperates with the double threading of the guide bar (107) to displace the guide (103) 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 (103) reaches an end of the guide bar (107). The rotary unit described above forms part of the known art: more details on the rotary unit are provided in a later passage.

[0042] The guide (103) for guiding the unwinding/rewinding hose (or other windable material) may 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.

[0043] A problem arising with this conventional arrangement is that a violent tug on the hose, ie an excessive force in the direction denoted by the shaded broad arrow in Fig 1B, may damage the hose or cause a blockage therein, and there is need for an arrangement in which such force is moderated or dampened. This disclosure set outs how this is achieved by the current invention and also explains how the current invention is not limited to any particular diameter of the winding material and facilitates winding of material of different diameters.

[0044] Reference is also made in this disclosure to the misaligned pulling force by which the windable material is pulled in a direction excessively divergent from the "normal" pulling force on the windable material (denoted by 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 $\alpha°$ with the horizontal plane) or can be in horizontal plane (making an angle $\beta°$ 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/pulley (103/104). Later passages set out how this is eliminated in embodiments of the invention.

[0045] Figs 2A, 2B and 2C show front, cross-sectional (side) and general perspectives of a guide according to an embodiment of the invention, the guide (203) comprising a first pulley (204), a rotary unit and also a guide bar (207) on which the first pulley (204) is mounted. Fig 2B shows both a cross-section (in the plane designated by AA in Fig 2A) and a cross-section (in the plane designated by CC in Fig 2A). This arrangement comprises at least one spring (205) which is configured to mount

the first pulley (204) on the guide bar (207) and permit transverse displacement of the first pulley (204) with respect to the axis (207a) of the guide bar (207), the direction of the displacement being perpendicular to the axes (204a, 207a) of the first pulley (204) and guide bar (207), these axes (204a, 207a) being parallel to each other (but perpendicular to the displacement). The first pulley (204) is attached to the at least one spring (205) by a plurality of attachment means (210) A rotary unit (211) (illustrated first in Fig 2C), which mounts the at least one spring (205) on the guide bar (207) may also be comprised in the guide (203) and is explained in more detail in a later passage.

[0046] The spring (205) serves, in effect, as a "suspension system" for the first pulley (204), moderating or absorbing the impact of excessive tugging or shocks on the windable material (not shown in Fig 2) and dampening vibrations of the windable material. As a suspension system, the spring mounting (205) permits a degree of "give" if a flexing force (see below) is applied to the pulley (205) (by the windable material (202)), the spring serving as a "shock absorber" against uneven or excessive forces, thereby cushioning the windable material (202) from damage. The reader will understand that the first pulley (204) is thus spring-mounted on the guide bar (207) and configured to rotate about the guide bar (207), but the rotation of the first pulley (204) is unimpeded by the lateral displacement, as herein below described.

[0047] The at least one spring (205), according to the invention, comprises a hub or inner portion or central portion (206) with a plurality of flexure arms (209) extending, at their proximal ends (209a) thereof, radially from the inner/central/hub portion (206), the flexure arm(s) (209) being non-linear or arcuate, as seen in Fig 2B. The flexure arms (209) of each spring (205) may be generally identical to each other in shape and dimension and are flexible (see below). The spring arrangement is generally rotationally symmetrical: depending on the number of flexure arms and their angular separation, rotation of the spring (205) by that angular separation would yield the "same" arrangement.

[0048] The distal ends (209b) of the flexure arms (209) may be joined in a single continuous component, which may be circular in form, or, alternatively, the distal ends (209b) may be separate and discontinuous: irrespective of whether the distal ends (209b) are joined to each other or are separate, they collectively form an outer peripheral portion (208) of the at least one spring (205). Fig 2D illustrates a spring arrangement, according to certain embodiments of the invention, with joined, and with separate, distal ends (209b) respectively, ie outer peripheral portions (208) in continuous and fragmented versions: for clarity reference signs have been used for only one of the three illustrated flexure arms (209). In cases where the distal ends (209b) are joined, as shown in the topmost configuration at Fig 2D, the spring arrangement, according to an embodiment invention, may be considered as analogous to a bicycle wheel, which also has an outer rim and a hub, the outer rim being joined to the hub by a number of spokes: the outer peripheral portion (208) would correspond to the outer rim, the flexure arms (209) would correspond to the wheel spokes and the hub would correspond to the wheel hub. Unlike the wheel spokes, the flexure arms (209) are however non-linear and flexible (see below). The middle configuration in Fig 2D shows a discontinuous outer peripheral portion (208), in which the distal ends (209b) of the flexure arms (209) are not joined, but nevertheless extend to a notional outer circumferential edge indicated by the dotted line. The bottom drawing in Fig 2D shows the same configuration (with discontinuous outer peripheral portion), but without the dotted line. Although the periphery of the spring is depicted herein as generally circular, other geometries are also envisaged, especially where the distal ends (209b) are discontinuous. As the reader will understand from the explanations below, since the attachment means (210) are in the corresponding locations at the distal ends (209b) of each of the flexure arms (209), which are identical, the spring (205) will function in the same way, irrespective whether the outer peripheral portion (208) is continuous or discontinuous.

[0049] Although the invention encompasses also non-continuous outer peripheral portions (208), the remainder of the disclosure focuses, for reasons of brevity, on spring arrangements (205) in which the outer peripheral portion (208) is continuous.

[0050] Although different geometries may be envisaged, the (dis)continuous outer peripheral portion (208) may generally be circular/annular (or cylindrical, see below) in shape (corresponding to the circular/cylindrical geometry of the first pulley), as shown in Figs 2B and 2C, and, schematically at Figs 2D, 3A, 3B and 3C, being herein as an outer ring (208). The outer ring (208) is aligned in a plane which is parallel to the plane of the first pulley (204), the planes of the first pulley (204) and the at least one spring (205) being perpendicular to the axes of the axes of the guide bar (207) and the first pulley (204). As explained in a later passage, the at least one spring (205) may be cylindrical, rather than circular in shape, in some embodiments: for brevity, references herein to *"circular"* geometries of the spring or references to *"inner/outer ring(s)"*, shall include cylindrical geometries, as appropriate.

[0051] The at least one spring (205) comprises an inner ring/annulus (or inner cylinder) (206), an outer ring/annulus (or outer cylinder) (208) and a plurality of flexure arms (209), each of the plurality of flexure arms (209: 209x, 209y, 209z) extending between the inner ring (206) and the outer ring (208), (in a manner analogous to (non-linear) spokes of a wheel), as shown, for example, at Figs 3A to 3C. The inner ring (206) and the outer ring (208) are, in the absence of any displacement of the outer ring (208) (see next paragraph), both coaxial with the guide bar (207), the inner ring (206) being rotatably mounted on the guide bar (207) and the first pulley being mounted, by means of attachment means (210) on the distal ends

(209b) of the flexure arms (209) or on the outer ring (208). Each flexure arm (209) may be non-linear and composed of an elastic material: it is configured to flex elastically under the influence of a flexing force F, the flexure reversing on removal of the flexing force F. The spring (205: 206, 208, 209) may be a single integral entity, fabricated by a suitable moulding process, but alternatively can be constructed by joining separately moulded components. Flexure of the arms (209) permits transverse displacement of the outer ring (208) relative to the inner ring (206), while nevertheless maintaining the connection of the outer ring (208) to the inner ring (206). The non-linearity provides flexibility in the flexure arm (209), as discussed below.

[0052] The nature of the transverse displacement of the first pulley and how this is facilitated by the spring mounting (205: 206, 208, 209) is now explained. Figs 3A to 3C show schematically the operation of the spring arrangement (205), illustrating, under influence of the flexing force F, transverse (lateral) displacement of the outer ring (208), in two exemplary directions, with respect to the inner ring (206). As stated above, transverse or lateral displacement of the outer ring (208), and therefore also transverse displacement of the first pulley (204) attached to the outer ring (208), refers to displacement of the outer ring (208) with respect to the inner ring (206) within the plane (for example in the plane CC, shown in Fig 2A) containing the inner and outer rings (206,208). The first figure, Fig 3A, schematically illustrates the spring (205) without any relative displacement of the rings (206,208) ie an equilibrium position, in which the spring (205) is in an "unflexed state" and the inner and outer rings (206,208) with axes (206a, 208a) are coaxial. Fig 3B shows lateral displacement of the outer ring (208) in a first direction, under the influence of flexing force F, indicated by the solid arrow therein, while Fig 3C indicates lateral displacement of the outer ring (208) in the opposite direction (under the influence of flexing force F, shown by the solid arrow therein) to that shown in Fig 3B. In these two figures, Fig 3B and 3C, the spring arrangement is in a "flexed state". Despite the translations (or linear displacements) of the outer ring (208), as shown in the flexed state, there is no corresponding translation of the inner ring (206, which is static across Figs 3A to 3C. Unlike the coaxiality in the unflexed state, in the flexed state (Figs 3B and 3C) the axes (206a, 208a) of the inner and outer rings (206, 208) no longer coincide, the axis of the outer ring (208a) being displaced by an amount "D" in the respective directions from the axis (206a) of the inner ring (206). The displacements illustrated here are in a vertical direction, but the spring (205) will accommodate relative displacements in any direction within the plane of the spring (205), all of which are intended by use herein of the term "transverse/lateral displacement".

[0053] Figs 3A, 3B and 3C show that, for any given displacement "D", the relative movement of the outer and inner ring (208,206) is accommodated by the flexure arms (209: 209x, 209y, 209z), the arms nevertheless forming a connection at all times between the inner and outer rings (206, 208). Although Figs 2 to 6 show a spring with only three arms (209) per spring (205), the reader will understand that one, two, four or any suitable number of arms may be envisaged within the spring. As stated above, the spring (205) is rotationally symmetrical and the three flexure arms (209: 209x, 209y, 209z) are identical in shape and form, each arm (209: 209x, 209y, 209z) having a proximal end (209a) and a distal end (209b) (some reference signs shown, for clarity, only in Fig 3A). In Fig 3, the three flexure arms (209x, 209y, 209z) are subject to flexure in different directions. For any given relative displacement D of the outer and inner rings (206, 208), the flexing of the individual flexure arms (209: 209x, 209y, 209z) is not uniform, some arms, eg arm (209x) in Fig 3B, permitting the outer ring perimeter (208) to approach the inner ring (206), with other arms (on the other side of the inner ring), eg arms (209y, 209z) flexing, at the same time, in a different way to permit the outer ring perimeter (208) to distance itself from the inner ring (206). The reader will understand from the foregoing that the pulley (204) is spring-mounted on the guide bar (207), but is still capable of rotation about the guide bar (207), irrespective of whether the pulley's axis (204a) is displaced with the outer ring axis (208a) from the axis (207a) of the guide bar (207).

[0054] Like any spring arrangement, the spring (205) has a spring bias, which, in the absence of, or after the removal of, the flexing force F, tends to return the outer ring (208) back to its unflexed position, where axes (206a, 208a) of the outer and inner rings (208, 206) coincide. As with all mechanical springs, the strength of the spring bias is determined by the dimensions of the spring (205), especially its flexure arms (209), the shape of the flexure arms (209) and the number of such arms (209), as well as the elasticity or rigidity of the material of which the spring (205) is composed.

[0055] As stated above, the spring arrangement(s) does(do) not interfere with the rotation of the first pulley (204) which is free to rotate in accordance with the movement (direction of shaded arrow in Fig 1B) of the section of windable material (202) contained within the guide (203) with which the first pulley (204) is engaged. When a spring arrangement (205) is in the unflexed state, the axes (206a, 208a) of the inner and outer rings (206, 208) are coaxial with the axis (204a, 207a) of the first pulley (204) and the guide bar (207). The plane of the spring (AA, BB or CC in Fig 2A) arrangement is perpendicular to the axis (204a) of the pulley (204). In the flexed state, caused by a *transverse* displacement of the outer ring (208), both the outer and inner ring (208, 206), as well as the entirety of the flexure arms (209), remain in the same plane. Apart from the lateral displacement of the rotational axis (204a) of the main pulley (204) (ie along the line AA, BB or CC), the rotation itself of the pulley (204) is otherwise not modified by any flexing of the flexure arms (209). From Figs 3A to 3C the reader will understand that, during a single revolution of the first pulley

(204) (and therefore a single revolution of the spring arrangement (205)) the flexure will "transfer" from one flexure arm (eg 209x) to the other (eg 209y, 209z), as each flexure arm (209x, 209y, 209z) spans greater or lesser separations between the inner (206) and outer rings (208).

[0056] In an embodiment of the invention the arrangement comprises two springs ((205) each as previously described), mounted parallel to each other, coaxially on the guide bar (217), on either side of the pulley (204). The exploded view at Fig 4 illustrates this arrangement, with attachment means (210) fixing the outer ring (208) of each spring (205) to a side of the pulley (204) (ie generally in the planes indicated as CC and BB of Fig 2A), which is then free to rotate (with the two springs (205)) about the guide bar (207). The figure shows also that the inner rings (206) of the two springs (205) are each mounted on the rotary unit (211), which is illustrated dismantled in two parts. Being mounted on the outer rings (208) or distal ends (209b) of flexure arms (209) of the springs (205), the pulley (204) is non-rotationally mounted on the rotary unit (211), such that the pulley (204) and the two springs (205) rotate with the rotary unit (211) which is free to rotate about the longitudinal axis (207a) of the guide bar (207). The rotary unit (211) is explained in more detail in a later passage.

[0057] In the embodiment illustrated at Fig 4 each attachment means (210) comprises a screw (210b) which attaches an attachment aperture (210a) of the outer rings (208) or distal ends (209b) of flexure arms (209) to a threaded receiving hole (210c) in the flank of the first pulley (204). Note that, although Figs 2B, 2C, 4 and other figures depict the attachment means (210) as comprising a screw joining the flexure arms (209) or outer portion (208) to the circumference of the pulley (204) or to the body/flank of the pulley (204), attachment means (210) other than screws are also envisaged. For example, the outer portion (208) may be configured to "clip" onto the circumference of the first pulley (204), which is configured, eg by means of a corresponding groove, to receive the outer ring (208) and be attached to it. An attachment means (210) may be permanent or reversible.

[0058] A spring (205) may be located on at least one side or flank of the pulley (204) (eg, in the plane CC or BB, see Fig 2A), as referenced above (and shown in Fig 4), or, alternatively, maybe *inside* the pulley (204) (eg in the plane AA), and different attachment means (210), also broadly in the plane AA) may be envisaged for attaching the outer ring (208) of the spring (205) to the pulley (204). Where the spring (205) is located in the plane AA the outer ring (208) may be cylindrical rather than circular, the depth of the outer "cylinder" (208) extending most or all of the width of the inner surface of the pulley (204).

[0059] Figs 5A and 5B show a general perspective of the guide arrangement (203) according to an embodiment of the invention, illustrating a first pulley (204) spring-mounted on a guide bar (207), by means of two springs (205) (only one of which is visible in this drawing), the guide (203) being loaded with the winding material (202). The reader will appreciate how the arrangement allows the outer ring (208) of each spring (205) and the pulley (204) mounted on it, to withstand uneven pulling forces (as described previously) on the windable material (202). In the absence of any flexing force F on the spring (205), the rotation of the outer ring (208) and the pulley (204) is coaxial with the guide bar (217). Any flexing force F will cause transverse displacement of the spring-mounted pulley (204), toward or away from the guide bar axis (207a), as previously described (in relation to Fig 3), without interfering with the rotation of pulley (204) and springs (205), the two springs acting in unison, flexing and displacing together. One advantage of an arrangement (203) in which the pulley (204) is mounted on two parallel springs (205) (as seen in the exploded view in Fig 4), either side of the pulley (in the planes CC and BB of Fig 2A) as described above, is that the arrangement (203) is particularly strong and stable. The reader will appreciate that, as the pulley (204) is supported on two sides (by the two springs (205)) the plane of rotation of the pulley (204) is less likely to be perturbed or become misaligned and rotation is guaranteed about an axis (204a) parallel to the guide bar (207).

[0060] As stated above, the inner component (206) of a spring (205) may be cylindrical, rather than annular, in form, its axis extending coaxially along the guide bar (207). In the arrangement described above, with a spring on each side of the pulley (ie generally in the planes CC and BB of Fig 2A), the two inner rings (206) may be joined as a single inner *cylinder* (206) coaxially mounted on the rotary unit (211), with each of the two outer rings (208) connecting, via its respective flexure arms (209), to the opposite ends of the single inner cylinder (206a). In this configuration (not shown in the drawings) the inner cylinder (206) extends between the innermost ends of the flexure arms (209) two springs (205) and in effect serves as the inner ring (206) for the two springs (205).

[0061] As shown in Figs 5A and 5B shows a guide bar (207) comprising a double-threading (207a) (the double-threading being used in the prior art) and a rotary unit (211) which engages with the double-threading. The at least one spring (205) is non-rotatably mounted on the rotary unit (211) (which is itself coaxially rotatable on guide bar (207)), such that the rotary unit (211) and the at least one spring (205) together rotatable about the longitudinal axis (207a) of the guide bar (207). For the reasons already set out herein, the first pulley (204) is also rotatable about the guide bar (207), but its axis of rotation (204a) may be transversely displaced (by distance D shown in Fig 3) The purpose of the double-threading (207b) together with the rotary unit (211) is to convert rotation of the first pulley (204) into longitudinal translation of the pulley (204), spring (205) and rotary unit (211) *together* along the guide bar (207), the rotary unit (211) ensuring reversal of the direction of the longitudinal translation whenever the pulley (204) arrives at

an end of the double threading (207b).

[0062] The longitudinal displacement of the spring-mounted pulley (204) along the guide bar (207) is explained with reference to Fig 5B: movement of the winding material (202) in the X-direction, and consequential rotation of the first pulley in the Z-direction, causes, by means of the double-threading (207b) on the guide bar (207), a corresponding displacement (the longitudinal translation, referred to above) of the pulley (204) in the Y-direction, and, vice-versa, displacement of the pulley (204) in the Y-direction causes a corresponding rotation in the Z-direction and a corresponding displacement of the windable material (202) in the X-direction. 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), as shown in Figs 6A and 6B which show transverse and front views of a guided system, with drum (201) and guide (203), according to an embodiment of the invention, and how the guide (203) cooperates with the drum (201). Fig 6A 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 6B shows the same arrangement but from a perspective which is perpendicular to that in Fig 6A. Fig 6A illustrates passage of the windable material (202) over the spring-mounted pulley (204, 205) of the guide arrangement (203) after being peeled off from the windings on the drum (201). In the perspective illustrated in Figure 6B 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), with a guide (203) mounted on the guide bar (207).

[0063] In an embodiment of the invention, a "multiple-pulley" arrangement comprises a first pulley (304) rotatably mounted, by means of at least one spring (305), as described previously in relation to other embodiments, on a guide bar (307), in combination with at least one auxiliary pulley (312, 313). The at least one spring (305) is as described in reference to earlier (single pulley) embodiments, being configured to accommodate transverse displacements of the first pulley (304) perpendicular to the axis (207a) of guide bar (307). The first pulley (304), the at least one spring (305) and the at least one auxiliary pulley (312,313) are rotatably mounted on a guide frame (314), the axes of rotation (304a, 312a, 313a) of the first pulley (304) and the auxiliary pulley(s) (312,313) being, in the absence of any flexing force (described previously) on the spring(s) (305), parallel to the longitudinal axis (307a) of the guide bar (307). The guide frame (314), the spring-mounted first pulley (304) and the at least one auxiliary pulley (312,312) collectively form a guide (303) for receiving and guiding a section of windable material (302), the guide (303) being displaceably mounted by a rotational unit (311), as previously described in respect of other embodiments, on the guide bar (307). The guide frame (313) is composed of a rigid material and is itself pivotally suspended on the guide bar (307) and free to rotate (as shown by the curved arrow GG in Fig 7B) about the axis (307b) of the guide bar (307).

[0064] Figs 7A, 7B and 7C illustrate such a multi-pulley embodiment, according to the invention, in more detail: Fig 7A is a cross-section of the embodiment, Fig 7B is an external view of the embodiment from the same perspective as Fig 7A, and Fig 7C shows a general perspective of the guide (308) mounted on the guide bar (307). Note that, while the multi-pulley embodiment according to the invention, illustrated at Figs 7A, 7B and 7C (and Fig 8), comprises two auxiliary pulleys (312, 313), the reader will understand that configurations with one auxiliary pulley, or three auxiliary pulleys, may also be envisaged. The auxiliary pulleys (312,313) may be identical in form and size (as shown in the drawings) but are not limited thereto. The reader will also understand that the spring mountings (305), illustrated in Figs 7B and 7C and discussed herein in reference to the first pulley (304), are nevertheless not limited to the mounting of the first pulley (304) and may be envisaged to mount any pulley (first pulley (304) and/or any of auxiliary pulley(s) (312,313)) on the guide frame (313). The operation, form and configuration of each of the at least one spring in relation to a spring-mounted pulley in a multi-pulley embodiment is as previously described for other embodiments.

[0065] In accordance with an exemplary aspect of the arrangement herein disclosed, Fig 7A shows a portion of the windable material (302) in the guide (303), aligned horizontally, as at Figures 6A and 6B. The spring(s) (305) are not visible in Fig 7A but are shown in Figs 7B and 7C, where they are depicted in the planes BB/CC (previously described). Alternatively (not shown) the spring (305) could have been in the plane AA (see Fig 2). The three pulleys (304,312,313), in frictional contact with the windable material (302), are free to rotate due to the movement of the windable material (302), about their respective axes (304a, 312a, 313a), which are parallel to each other. The three axes (304a, 312a, 313a) of the three pulleys (304,312,313) are perpendicular to the axis of the portion of the windable material (302) in the guide. The three pulleys (304,312,313) are held in a positional relationship by the rigid guide frame (314) of the guide (303), as shown at Fig 7A. As the windable material portion (302) is moved longitudinally, in one (left or right in the sense of Fig 7A) of the X-directions indicated by the doubleheaded arrow, the windable material (302) engages on a first side (302a) of its surface (the upper surface in the perspective of Fig 7A) with the first pulley (304) and, simultaneously, engages on its second side (302b) of its surface (lower surface in the perspective of Fig 7A) with the two auxiliary pulleys (312,313), causing all three pulleys (304,312,313) to rotate about their respective axes (304a,312a,313a)

[0066] Fig 7B depicts a side perspective/cross-section of a multi-pulley arrangement of the invention, with the

spring mounting (305) of the first pulley (304), as well the guide frame (314). The windable material (302) is not shown. As previously explained in relation to other embodiments, the spring mounting (305) is configured to accommodate transverse displacements of the first spring (304) and its rotational axis (304a) (see Figs 3A to 3C), while permitting such rotations. The operation of the spring (305) and the flexure of the flexure arms (309), facilitating the transverse displacements (relative lateral movements of the inner ring (306) and outer ring (308), was described above in relation to another embodiment. Subject to these relative transverse displacements of the spring mounted pulley, the rigidity of the guide frame (314) maintains the relative spatial/angular configuration of the three pulleys (304, 312,313). The guide frame (314) is itself rotatable about the longitudinal axis (307a) of the guide bar (307), such that the said spatial/angular configuration is also rotatable, as shown by the curved arrow GG. Fig 7B illustrates the arrangement in the absence of any flexing force, ie with no transverse displacement.

[0067] Fig 7C shows another view of the guide (303) illustrated in Figs 7A and 7B, comprising the first pulley (304), the at least one spring (305) (just visible behind the guide frame), and the at least one auxiliary pulley (312,313) are rotatably mounted on the guide frame (314), the guide being mounted rotatably (pivotally suspended, see above) and displaceably on the guide bar (307). The arrangement may also comprise double-threading (307b) as set out previously in relation to other embodiments.

[0068] The operation of the multi-pulley guide (303) according to an embodiment of the invention will now be explained in reference to Figs 7A and 7B. As stated above, the first pulley (304) and the two auxiliary pulleys (312,313) are restricted to a spatial/angular configuration determined by the guide frame (314). Within this configuration the linear and angular separation between the first pulley (304) and two auxiliary pulleys (312,313) would be fixed, were it not for the axis of the first pulley being transversely displaceable, as described in reference to Figure 3 (in relation to earlier embodiments), due to the spring-mounting (305) of the first pulley (304). In the arrangement shown in Figs 7A (and in Figs 7B and 7C, where, for clarity, the windable material has been omitted) the auxiliary pulleys (312,313) engage with the lower surface (302b) of the windable material (302) (where "lower" is as viewed in the perspective of Figs 7A and 7B). The auxiliary pulleys (312,313) serve to provide frictional contact between the upper surface (302a) of the windable material (302) and the first pulley (304) (where "upper" is as viewed in the perspective of Figs 7A and 7B): by virtue of the engagement of the guide (303) on *both* of the opposing surfaces (302a, 302b) the engagement with the windable material (302) is clearly enhanced and the risk of disengagement considerably reduced or eliminated. In the specific case of a three-pulley arrangement (as shown in Figs 7A to 7C), the triangular configuration of the three pulleys (304,312,313) the auxiliary pulleys (312,313) "cradle" the winding material (302) about the first pulley (304). In accordance with this engagement and/or "cradling" function, the auxiliary pulleys (312,313) force the windable material (302) into engagement with the first pulley (304), without impeding the longitudinal movement (direction Z) of the material (302). The multi-pulley arrangement "traps" the windable material (302) within the guide (303), thereby minimising the risk that the windable material "escapes" from the guide's control and promotes correct (even) unwinding or rewinding of the material (302) from/on the drum, as referenced above, as well as the avoidance of kinks and other deformations.

[0069] This engagement or "cradle" effect, referenced above, is further enhanced by the action of the spring(s) (305) acting on the first pulley (304) the spring's bias tending to return the first pulley (304) toward the equilibrium position (shown in Fig 3A), as explained in more detail below.

[0070] In accordance with an embodiment of the invention, as shown in Figs 7A, 7B and 7C, the guide frame (314) may be pivotably suspend on the guide bar (307), the frame (314) being rotatable about an axis of rotation coinciding with the central longitudinal axis (307a) of the guide bar (307): it is free to swing under the effect of gravity and its longitudinal axis (its axis of symmetry in Fig 7B) will always be aligned with the vertical (line HH in Fig 7B). The first pulley (304) is supported by the guide frame (314), and both are mounted on the guide bar (307), but the rotation of the first pulley (304) is separate and independent of the rotation of the frame (314). The rotation of the first pulley (304), as referenced above, is driven by any displacement of the windable material (302), whereas any rotation of the frame (314), which is pivotably hung/suspended on the bar guide (307), is determined largely by its own weight. As the guide frame (314) is freely suspended from the guide bar (307) about which it pivots, as shown by the arrow GG (Fig 7B), the orientation of the guide frame (314) is self-adjusting. This self-adjustment may be considered analogous to a compass which always "finds North", as the frame (314) will always find, after a brief adjustment time lag, an equilibrium orientation in which it is symmetrically aligned around the line HH (in Fig 7C), irrespective of the orientation of the drum-guide arrangement.

[0071] In accordance with an embodiment of the invention, the advantages (engagement and self-orientation) of a multi-pulley arrangement are further enhanced by the spring bias provided of spring mounting (305) of the first pulley (304), as set out in the following passage with reference to Fig 8.

[0072] In such multi-pulley arrangements it will be appreciated that good engagement of the section of windable material (302) would normally require suitable dimensioning of the rigid frame (314) and, more specifically, careful selection of the distance between axes of the first pulley (304) and the auxiliary pulleys (312,313), marked "s" in Fig 8. An advantage of incorporating a

spring mounting (305) in a multi-pulley arrangement is that the selection of the s-value can be more flexible. Its spring bias, which, in the absence of, or after the removal of, the flexing force F, tends to return the outer ring (308) back to its unflexed position where the outer and inner ring axes (306a, 308a) coincide: the spring bias seeks to reduce D (in Fig 3) back to zero. The spring bias is exploited in repositioning the first pulley (304) which is mounted on the spring (305): in seeking to re-adopt the equilibrium (unflexed) position, described in relation to Fig 3, the spring bias "pushes" the first pulley (304) toward the auxiliary pulley(s) (312,313) and onto the windable material (302). The spring bias seeks to restore the outer ring (308) (and the first pulley (304)) back to the relative positions of the unflexed state and therefore exerts a *restoring* force on the first pulley (304) which, in turn, engages with the upper surface (302a) of the windable material (302).

[0073] Not only does this enhance the engagement with the windable material (302), but, more importantly, this effect (of the spring bias) functions over a range of diameters d and therewith eliminates the need to determine the size of s for each d. In other words, due to the spring mounting (305), different diameters d of windable material may be accommodated in the guide (303). The spring mounting (305) provides greater flexibility than a fixed (spring-free) mounting and can facilitate accommodation of a wider range of diameters of the windable material (302), as set out in the following passage, which relates to the transverse displacement of the first pulley (304) relative to the guide frame (314) and the auxiliary pulley(s) (312,313).

[0074] The operation of the spring(s) (305) by which the first pulley (304) is mounted on the guide bar (307), is set out above (in reference to Figs 3A, 3C and 3C). Although the spring mountings (305) are not visible in Fig 8, the reader will therefore understand the operation of the spring(s) (305) in the embodiment illustrated in Fig 8 facilitates lateral displacement of the first pulley (304) with respect to the guide frame (314) and the auxiliary pulley(s) (312,314), while the auxiliary pulley(s) (304) remain at a fixed distance from the guide bar (307).

[0075] Thus, due to the spring-mounting of the first pulley (304) the separation "s" of the axis (304a) of the first pulley from each of the axes (312a,313a) of the auxiliary pulleys is variable. By varying this separation "d" different diameters of the windable material can be accommodated. In Fig 8, the windable material (302) is shown as having a diameter "d", the upper surface (302a) of the windable material being in engaging contact with the inner surface (304b) of the first pulley (304) and the lower surface (302b) of windable material being in engaging contact with the inner surfaces (312b, 313b) of the auxiliary pulley(s). The windable material therefore engages with, on its upper surface (302a), the first pulley (304) and engages with, on its lower surface (302b), the auxiliary pulley (312, 313): the windable material (302), although free to move in a longitudinal direction X (as shown in Fig 7A), is therefore held (the "entrapment" referred to above) by the multi-pulley arrangement illustrated in Fig 8.

[0076] As stated earlier, in reference to other embodiments, the spring mounting (not shown in Fig 8) of the first pulley (304), may comprise two springs (305) on either side of the first pulley (304), or a single spring on one side of the first pulley (304) or a single spring (305) within the plane (plane AA in Fig 2A) of the pulley (304).

[0077] The spring mounting within the multi-pulley arrangement, as described in relation to other embodiments, provides the required engagement without impacting on or impeding the rotation of any of the pulleys (304, 312, 313). In these embodiments the first pulley (304) is not only rotatable, as described previously in relation to other embodiments, but also displaceable. As explained in reference to Figs 3A, 3B and 3C, this is achieved in the multi-pulley arrangement by means of the at least one spring (305) which, in the manner of a "suspension system" and "shock absorber", permits displacement of the axis (304a) of the first pulley with respect to the axes (312a, 313a) of the auxiliary pulleys (312, 313), the direction of the displacement being perpendicular to the axes (304a, 312a, 313a) of the pulleys (304, 312, 313), ie the axes (304a, 312a, 313a) of the pulleys remain parallel despite the transverse displacement (D in Fig 3).

[0078] An advantage of incorporating the at least one spring arrangement (305) into the multi-pulley system, according to an embodiment of the invention, is that the axis of the first pulley (304), mounted on the spring (305), can be transversely displaced. This is shown in the multi-pulley scheme in Fig 8 (which nevertheless, for clarity, omits the spring (305) itself). In view of the transverse displacement (D in Fig 3) the separation s is varied and different diameters d of the windable material (302) may thereby be accommodated, without detracting from the operation of a three-pulley arrangement. The bias of the spring arrangement (305) always attempts to revert to the unflexed position and to return the outer ring (308) to a state in which it is coaxial with the inner ring (306), ie pushing the outer ring (308) and the first pulley (304) onto the windable material (302) ensures engagement of the first pulley (304) on the upper surface (302a) of the windable material. Thus, the first pulley (304) impinges on the upper surface 302a of the windable material (302), while each of the auxiliary pulleys (312,313) engages with the lower surface (302b) of the windable material (302), irrespective of the diameter d.

[0079] As seen in Fig 8, this may be regarded as the spring(s) facilitating a shift of the axis (304a) of the first pulley (304) along the line HH in order to accommodate a section of windable material with a diameter d exceeding that corresponding to unflexed state of the spring(s). In order to accommodate a wider range of values of d the dimensions of the guide frame and the three pulleys may be selected such that the non-flexed state corresponds to a particularly narrow windable material, there-

by ensuring that all wider values entail a flexing of the spring(s) and a spring bias of a wider range of material diameters d. The solid arrow marked "B" represents the distance in the line HH between the inner surface (304a) of the first pulley (304) and the inner surfaces (312b, 313b) of the two auxiliary pulleys (312, 313) when the spring (205) is in the unflexed state. In this illustration, at Fig 8, the diameter d equals the distance B, but the reader will understand that this may not always be the case: a wider diameter d will require a greater clearance than afforded by the distance B in the unflexed state and the spring will consequently be flexed (ie the spring-mounted pulley will be transversely displaced to accommodate the wider d), but maintain good engagement of the pulleys on both sides of the windable material. The spring arrangement thus accommodates a large range of d-values without any loss of engagement.

[0080] The distance B (effectively the clearance in the unflexed state, between first and auxiliary pulleys) is determined by the relative dimensions of the three pulleys (304, 312, 313) and their relative positions on the frame (314). It is clear from Fig 8, that on condition that the d-value is not lower than the value of B, then engagement is ensured, while any d-value larger than the value of B. The distance B may therefore be selected at a relatively low level, in order that even narrow windable materials (with low d-value) may be accommodated and engaged by the three-pulley arrangement, and, due to the flexing of the spring and movement of the first pulley (304), all larger values of d will also per force be also accommodated and successfully engaged. The multi-pulley arrangement can in this way encompass a greater range of d-values, starting with a B distance corresponding to the lowest diameters commonly used for windable materials.

[0081] The windable material itself, whether wide or narrow, will have a uniform diameter, so the two branches of the specific 3-pulley arrangement in Fig 8 will have the same value of s. The symmetry of the specific 3-pulley configuration shown in Fig 8 will be respected for all values of s and d. In other words, both separations "s" of main and auxiliary pulleys shown in Fig 8 will always be equal to each other and the triangle shown therein will always be an isosceles triangle.

[0082] The cushioning, moderating, dampening or shock absorber effect of the spring mounting (305), described in an earlier passage herein, arises for all embodiments of the invention, thereby reducing the risk of damage to the guide and to the windable material (302) caused by excessive pulling forces.

[0083] The reader will understand that, in an alternative embodiment of the multi-pulley arrangement, the spring mounting could be applied to each of the auxiliary pulleys (312, 313), instead of to the first pulley (304), such that relative transverse displacement of the pulleys (304, 312, 313) on the guide frame (314) would also be achieved and the technical advantages discussed herein would be equally obtainable. The multi-pulley arrangement provided in an embodiment of the guide (303) disclosed herein, will retain the section of windable material (302) and ensure that it remains "in place", as well as preventing 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 (302) is *held* between the first pulley (304) above it and the two auxiliary pulleys (312,313) below it. This 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.

[0084] 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 bar with a longitudinal axis,
   - a first pulley for rotation coaxial with, or about an axis parallel to, the longitudinal axis of the guide bar, parallel to the axis of the drum, the first pulley being configured to engage with a section of the elongate windable material, and
   - at least one flexible spring for rotatably mounting the first pulley on the guide bar.

2. A guide as in Claim 1, wherein the at least one spring is configured to

   - in an unflexed state, rotatably support the first

pulley for rotation coaxially with the longitudinal axis of the guide bar, and
- in a flexed state, rotatably support transverse displacements of the first pulley, wherein the axis of rotation of the first pulley is parallel to, but displaced from, the longitudinal axis of the guide bar.

3. A guide as in Claim 2, wherein the at least one spring comprises an inner portion mounted rotatably on the guide bar and an outer perimeter portion attached to the first pulley, the outer perimeter portion being mounted on the inner portion by a plurality of flexure arms, the flexure arm(s) being non-linear and extending radially from the inner portion and configured

- to flex and
- to rotate the outer perimeter portion with rotations of the inner portion, and vice versa.

4. A guide as in Claim 3 wherein the flexure arms are configured to, when in a flexed state, support transverse displacements of the outer perimeter.

5. A guide as in Claim 4 wherein the inner portion and outer perimeter portion of the at least one spring are generally circular or cylindrical in geometry, and respectively form an inner ring/cylinder and outer ring/cylinder, these being rotatable about an axis parallel to the longitudinal axis of the guide bar.

6. A guide as in any previous claim, the guide bar comprising a double helix configured to longitudinally displace the guide along the guide as a function of the rotation of the inner ring spring.

7. A guide as in any previous claim, wherein the at least one spring comprises two springs, one on each flank of the first pulley.

8. A guide as in any previous claim, wherein the at least one spring comprises one single spring located within the first pulley in the main plane of first pulley.

9. A guide as in any previous claim, wherein the guide further comprises a guide frame for receiving a displaceable section of the windable material, the guide fame being mounted rotatably on the guide bar and being configured to rotatably mount the first pulley and at least one rotatable auxiliary pulley, the auxiliary pulley(s) being aligned in parallel with the first pulley.

10. A guide as in Claim 9 wherein

- the main pulley is configured to engage with a first side of the displaceable section of the windable material, and
- the auxiliary pulley(s) is/are configured to engage with a second side of the displaceable material section opposite the first side of the material section.

11. A guide as in 10 wherein the guide frame is freely rotatable about an axis parallel to the longitudinal axis of the guide bar.

12. A guide as in any of Claims 9 to 11, wherein the rotational axes of the two auxiliary pulleys are equidistant from the rotational axis of the guide frame.

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:

- providing a guide comprising a guide bar with a longitudinal axis, and a first pulley for rotation coaxial with, or about an axis parallel to, the longitudinal axis of the guide bar, parallel to the axis of the drum
- rotatably mounting the first pulley on the guide bar by means of at least one flexible spring
- engaging the first pulley with a section of the elongate windable material

Amended claims in accordance with Rule 137(2) EPC.

1. A guide for guiding an elongate windable material from/to a drum, the guide comprising

- a guide bar with a longitudinal axis,
- a first pulley for rotation coaxial with, or about an axis parallel to, the longitudinal axis of the guide bar, parallel to the axis of the drum, the first pulley being configured to engage with a section of the elongate windable material, and
- at least one flexible spring for rotatably mounting the first pulley on the guide bar.

2. A guide as in Claim 1, wherein the at least one spring is configured to

- in an unflexed state, rotatably support the first pulley for rotation coaxially with the longitudinal

axis of the guide bar, and
- in a flexed state, rotatably support transverse displacements of the first pulley, wherein the axis of rotation of the first pulley is parallel to, but displaced from, the longitudinal axis of the guide bar.

3. A guide as in Claim 2, wherein the at least one spring comprises an inner portion mounted rotatably on the guide bar and an outer perimeter portion attached to the first pulley, the outer perimeter portion being mounted on the inner portion by a plurality of flexure arms, the flexure arm(s) being non-linear and extending radially from the inner portion and configured

- to flex and
- to rotate the outer perimeter portion with rotations of the inner portion, and vice versa.

4. A guide as in Claim 3 wherein the flexure arms are configured to, when in a flexed state, support transverse displacements of the outer perimeter.

5. A guide as in Claim 4 wherein the inner portion and outer perimeter portion of the at least one spring are generally circular or cylindrical in geometry, and respectively form an inner ring/cylinder and outer ring/cylinder, these being rotatable about an axis parallel to the longitudinal axis of the guide bar.

6. A guide as in Claim 5, the guide bar comprising a double helix configured to longitudinally displace the guide along the guide as a function of the rotation of the inner ring/cylinder.

7. A guide as in any previous claim, wherein the at least one spring comprises two springs, one on each flank of the first pulley.

8. A guide as in any of Claims 1 to 6, wherein the at least one spring comprises one single spring located within the first pulley in the main plane of first pulley.

9. A guide as in any previous claim, wherein the guide further comprises a guide frame for receiving a displaceable section of the windable material, the guide fame being mounted rotatably on the guide bar and being configured to rotatably mount the first pulley and at least one rotatable auxiliary pulley, the auxiliary pulley(s) being aligned in parallel with the first pulley.

10. A guide as in Claim 9 wherein

- the main pulley is configured to engage with a first side of the displaceable section of the windable material, and
- the auxiliary pulley(s) is/are configured to engage with a second side of the displaceable material section opposite the first side of the material section.

11. A guide as in 10 wherein the guide frame is freely rotatable about an axis parallel to the longitudinal axis of the guide bar.

12. A guide as in any of Claims 9 to 11, wherein the rotational axes of the two auxiliary pulleys are equidistant from the rotational axis of the guide frame.

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:

- providing a guide comprising a guide bar with a longitudinal axis, and a first pulley for rotation coaxial with, or about an axis parallel to, the longitudinal axis of the guide bar, parallel to the axis of the drum
- rotatably mounting the first pulley on the guide bar by means of at least one flexible spring
- engaging the first pulley with a section of the elongate windable material

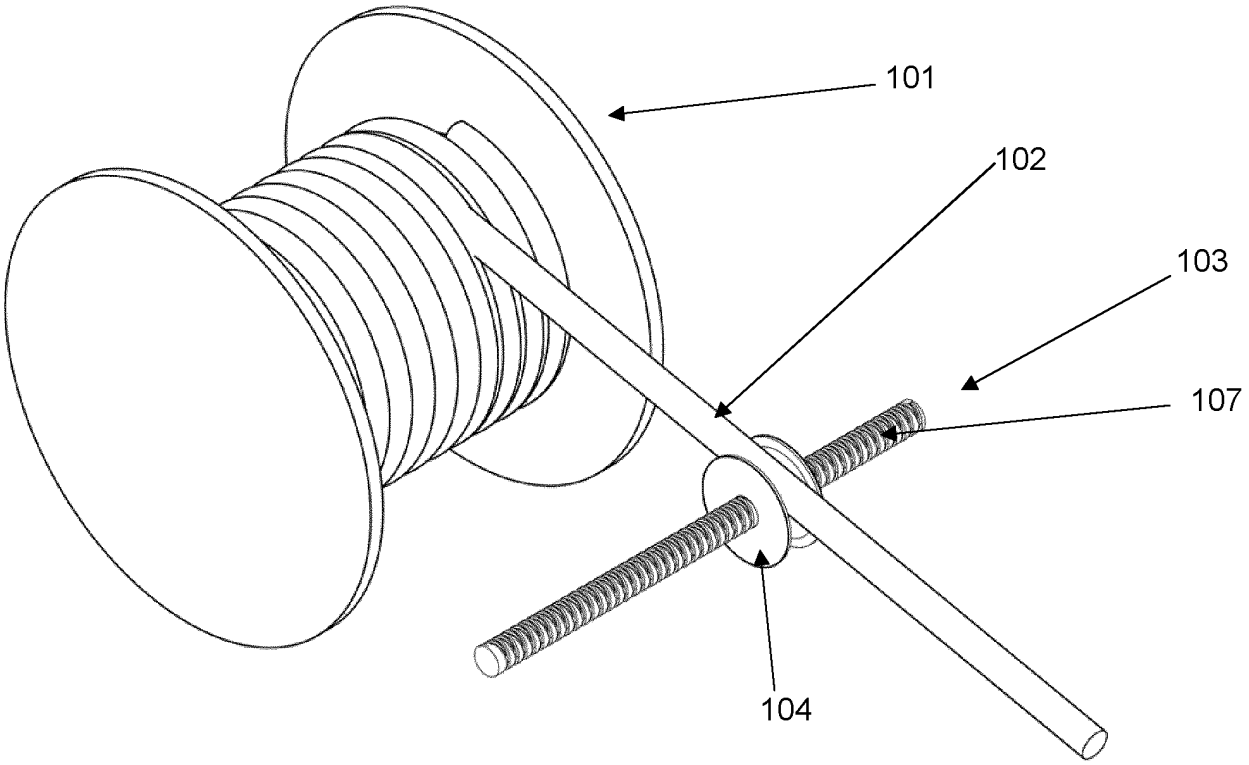


Figure 1A

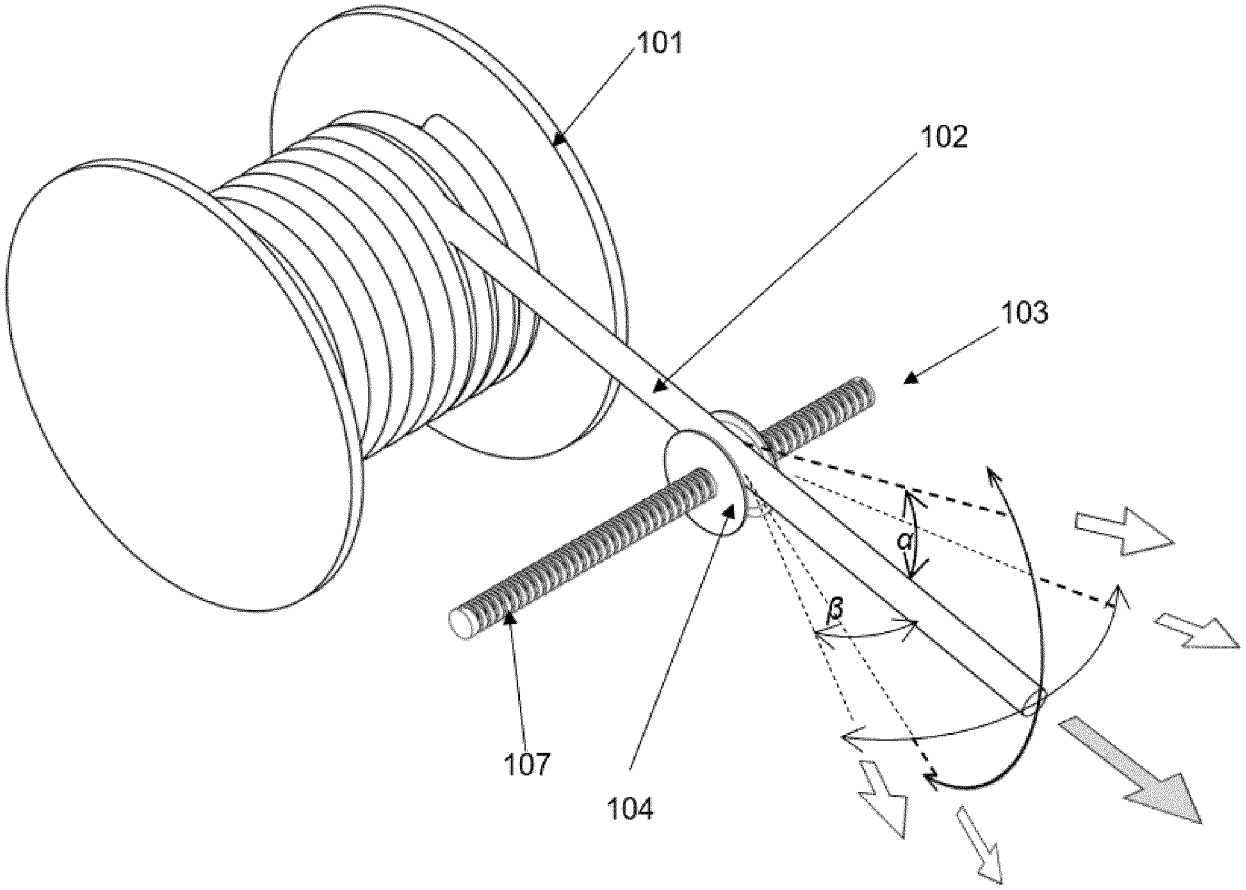


Fig 1B

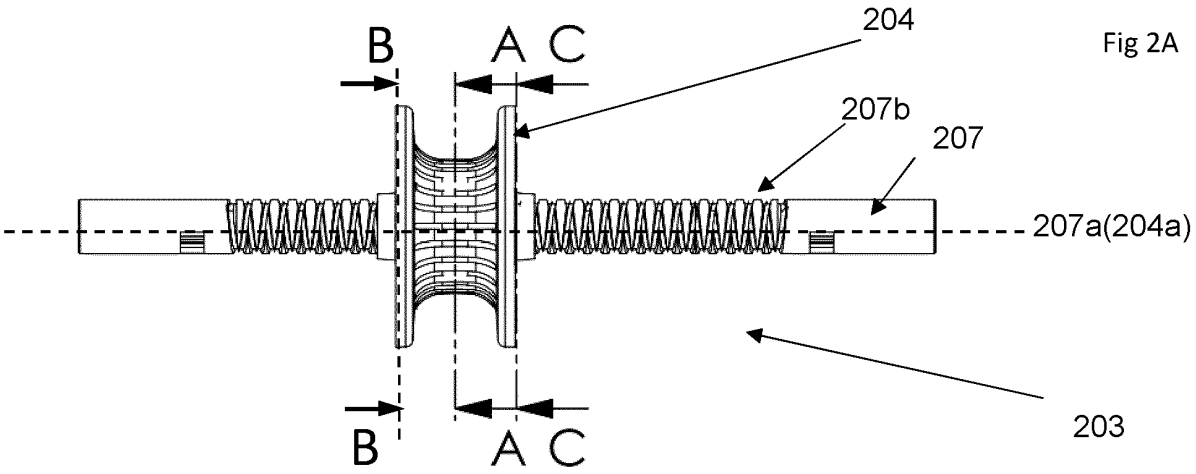
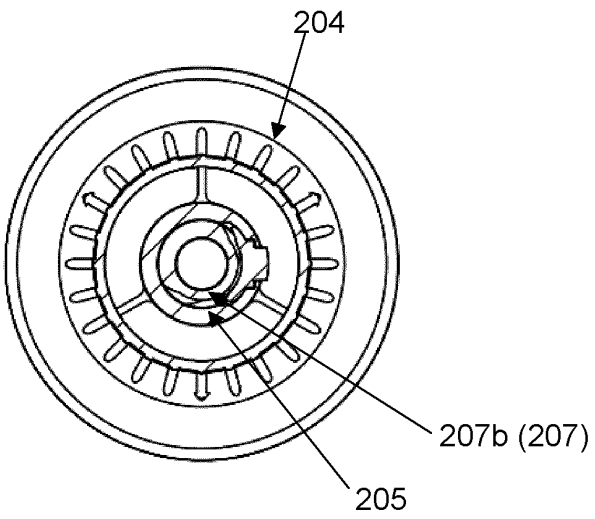


Fig 2A



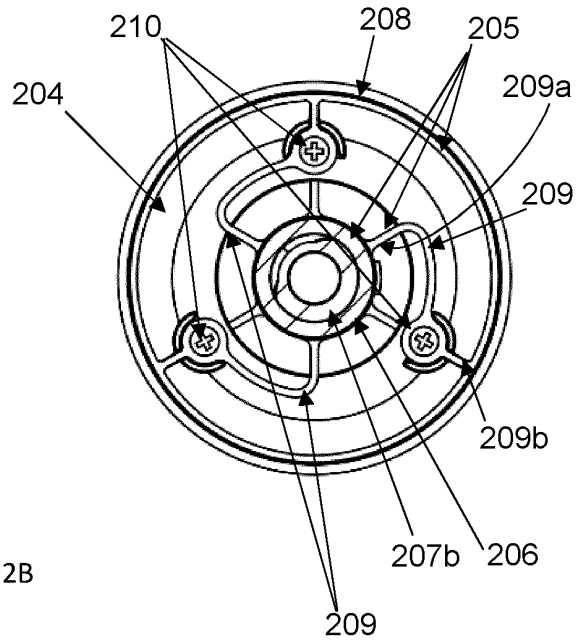


Fig 2B

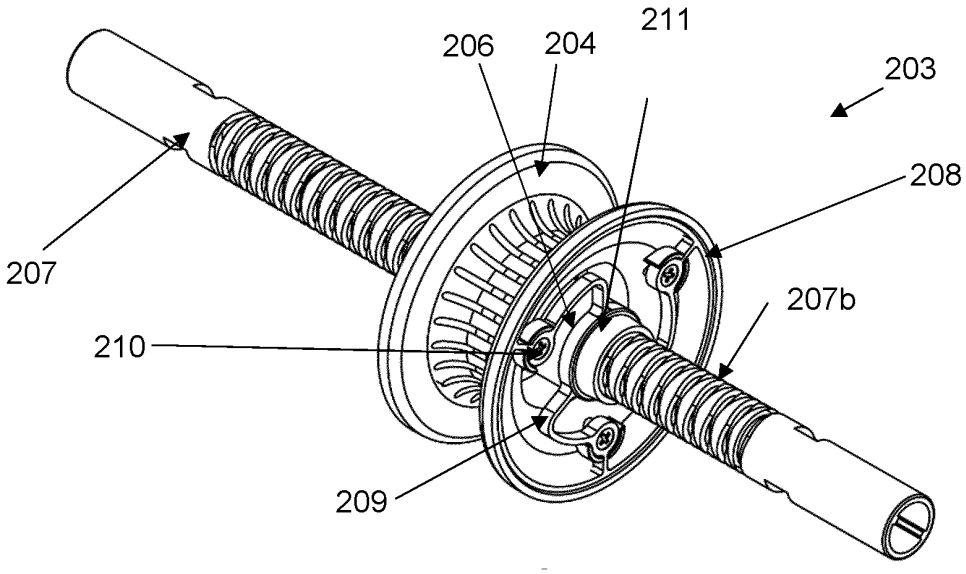


Fig 2C

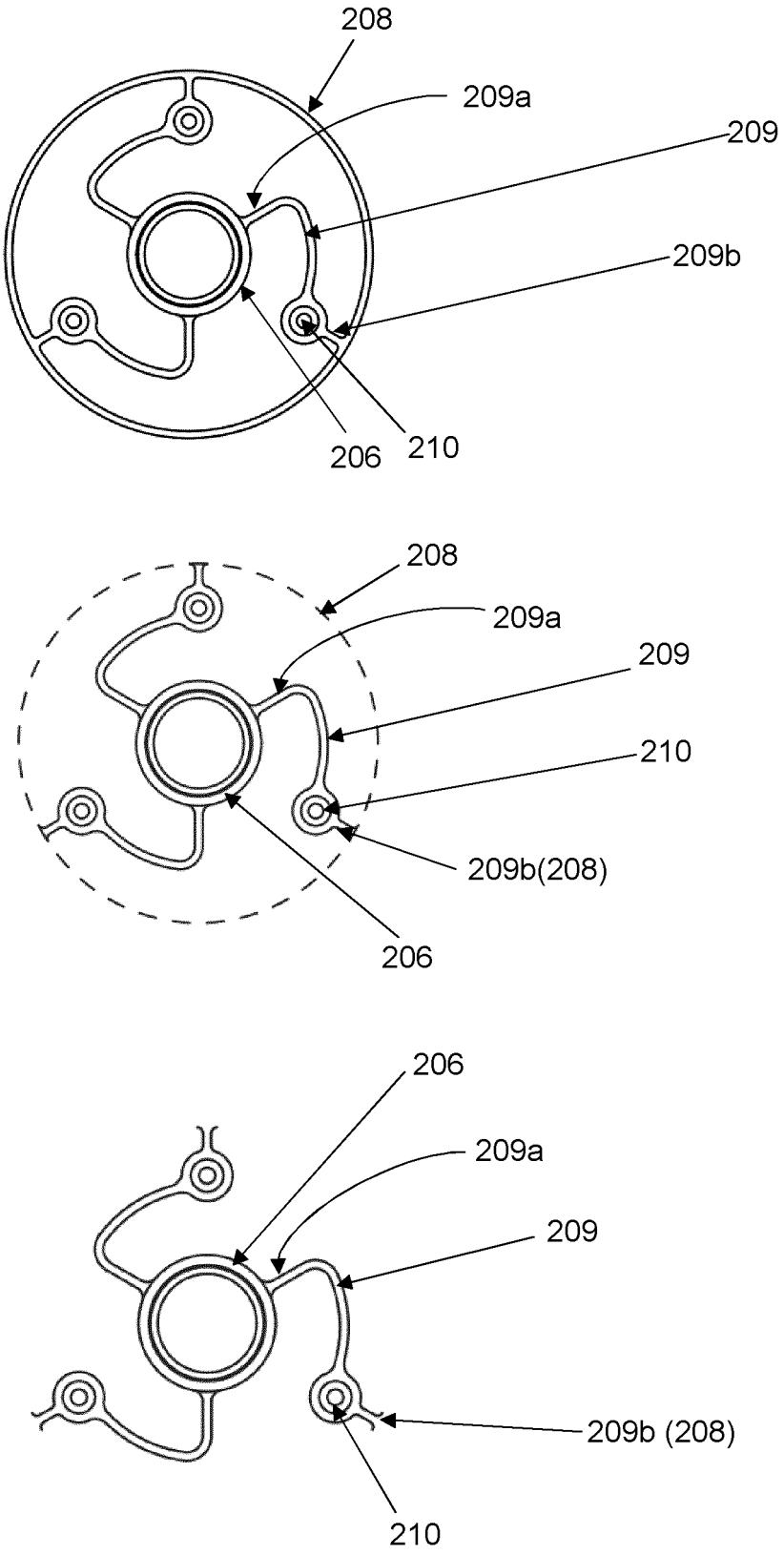

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Fig 2D

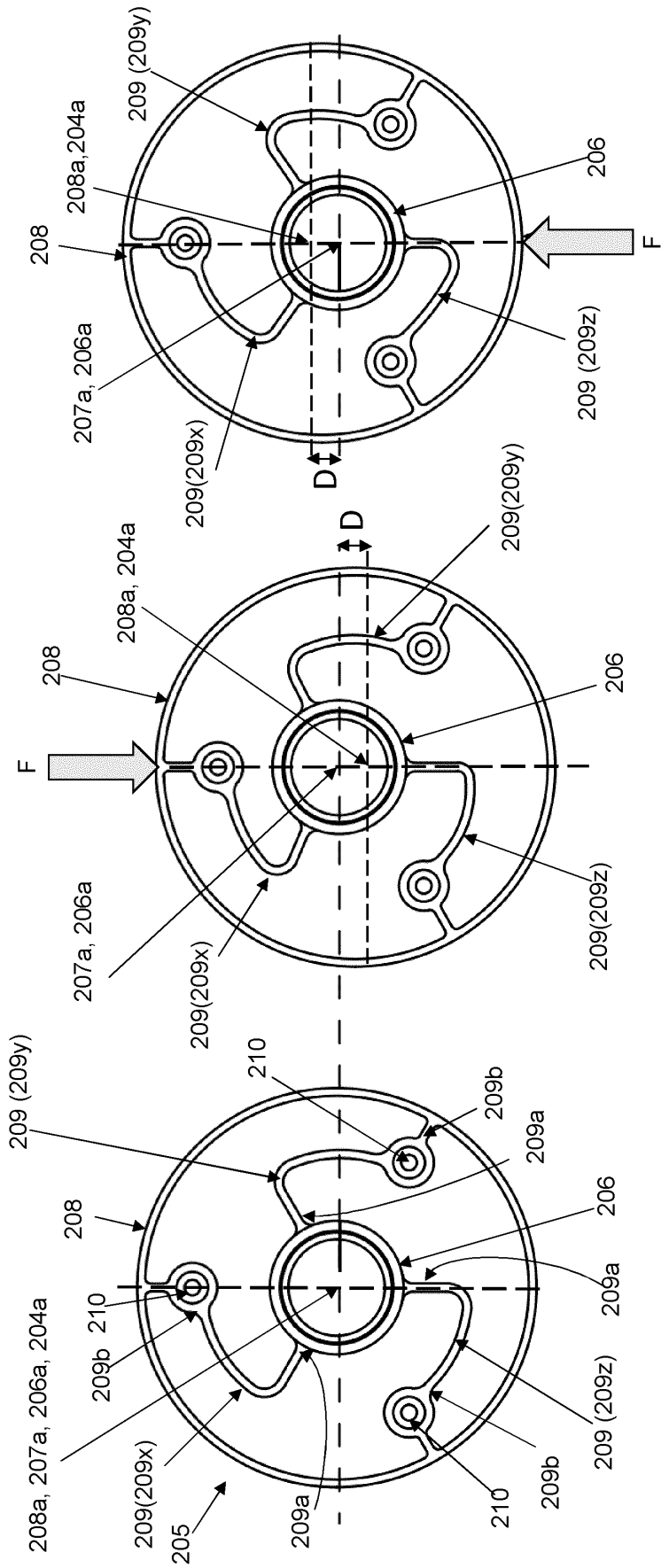

Fig 3A

Fig 3B

Fig 3C

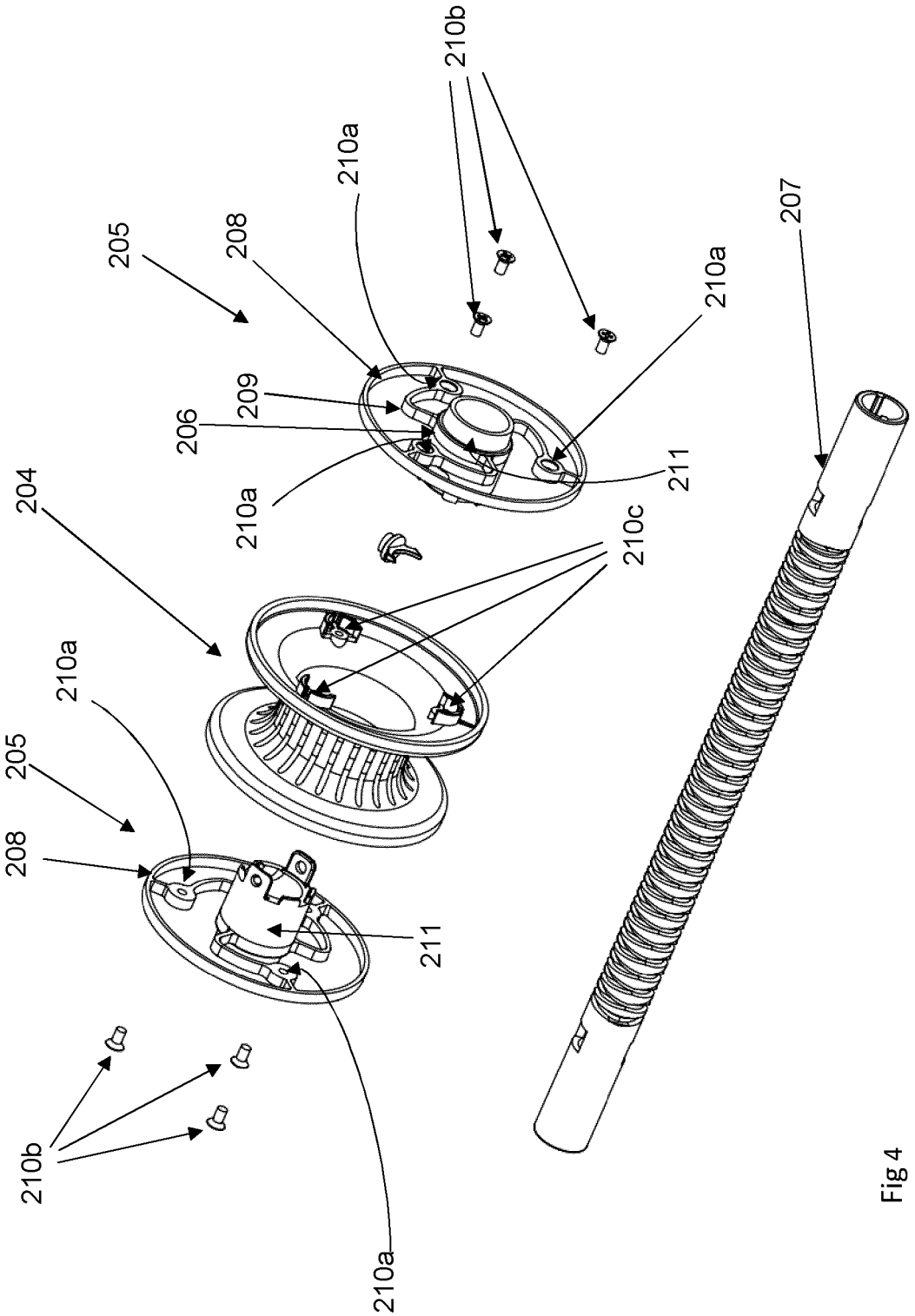
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Fig 4

Fig 5B

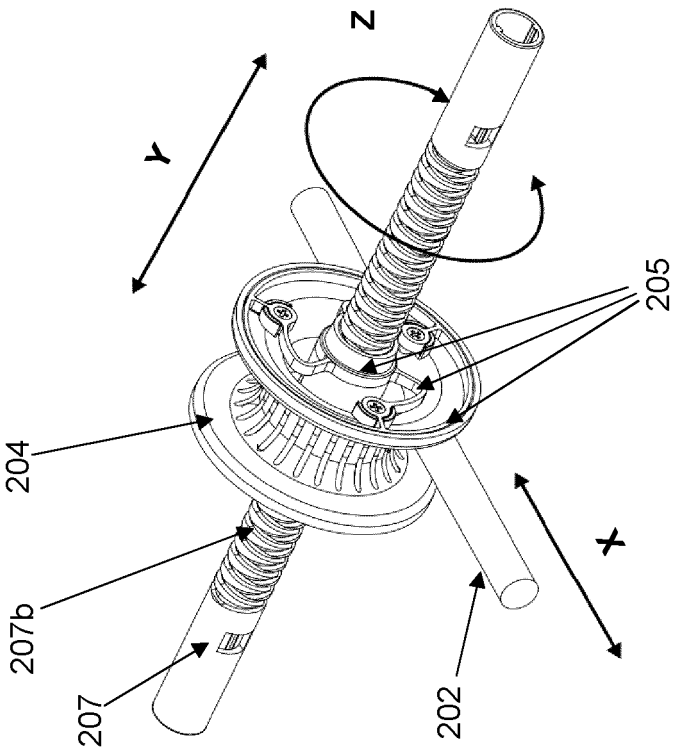
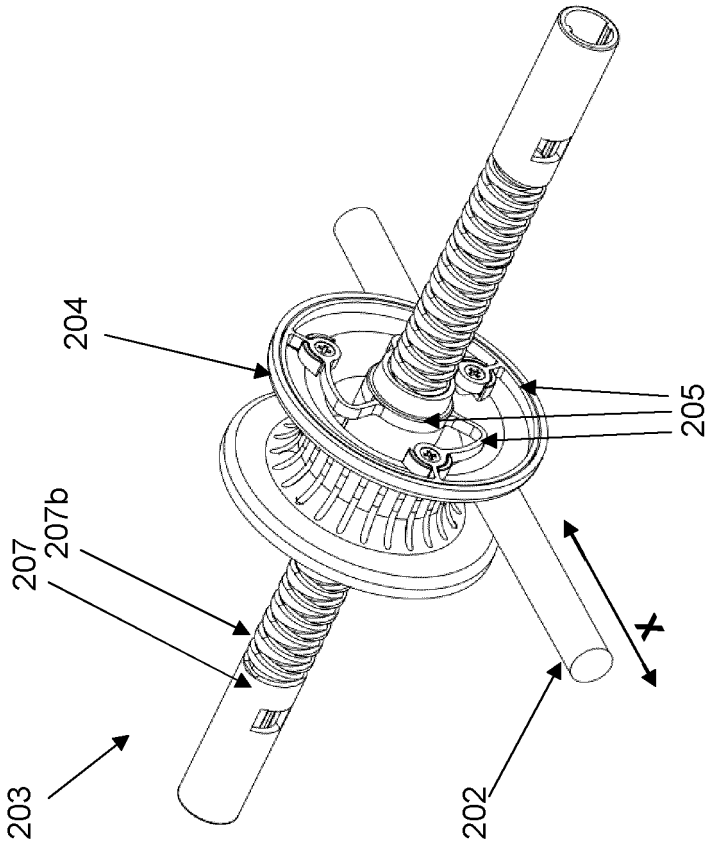


Fig 5A



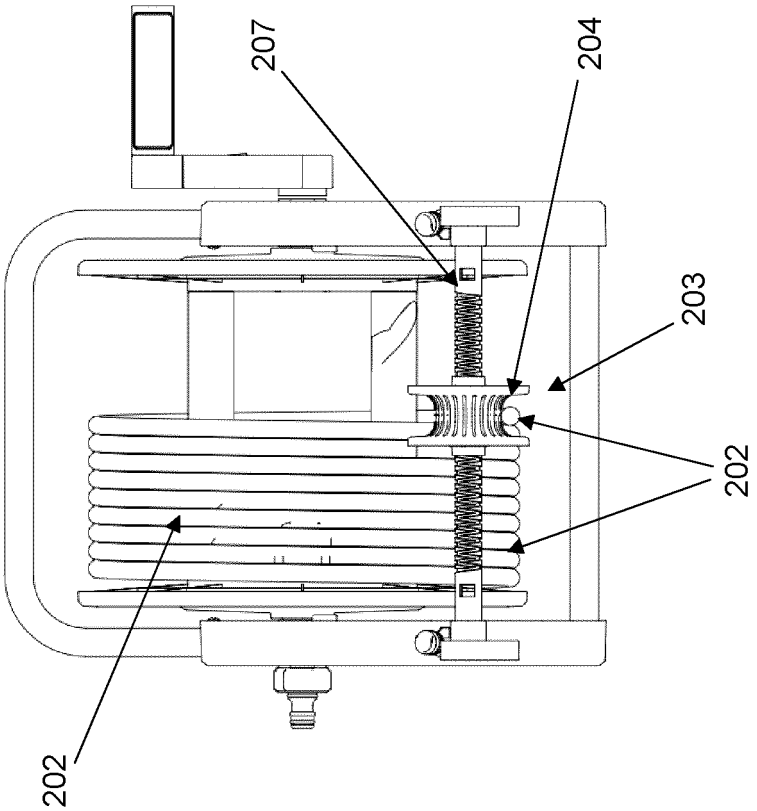


Fig 6B

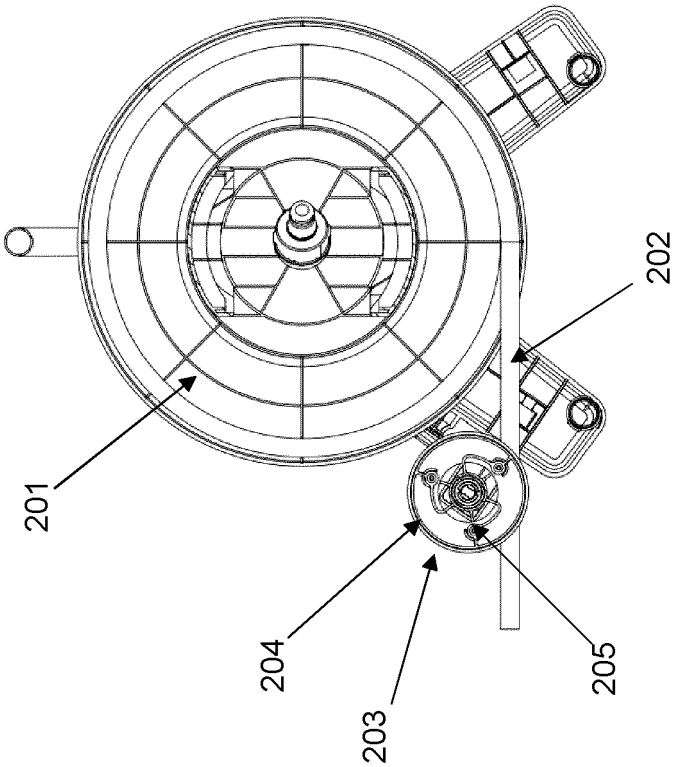


Fig 6A

Fig 7A

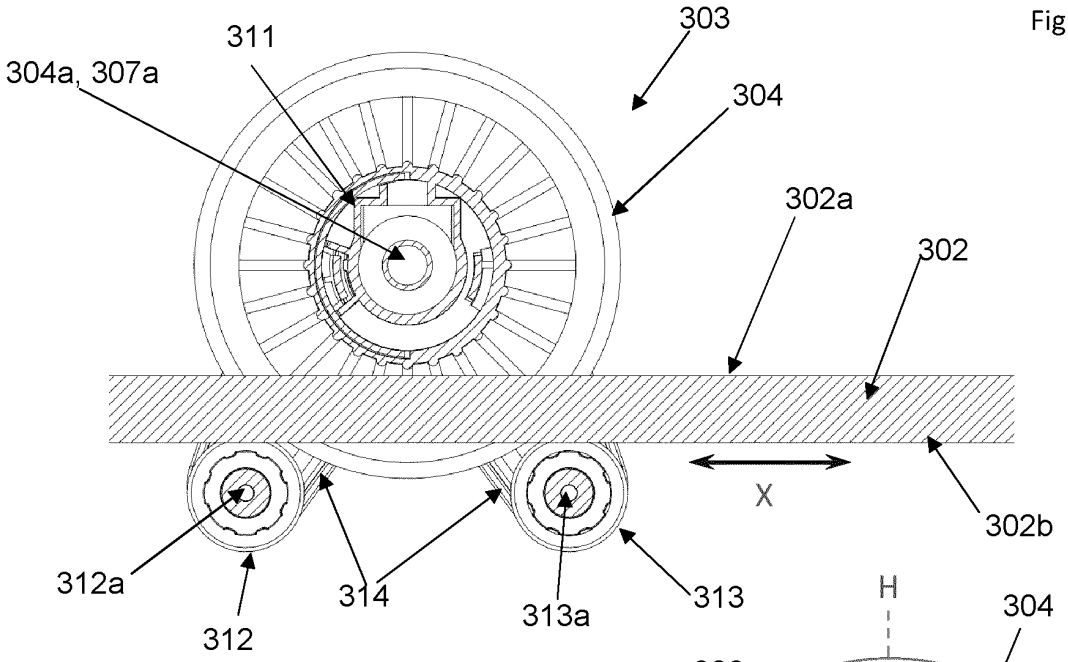


Fig 7B

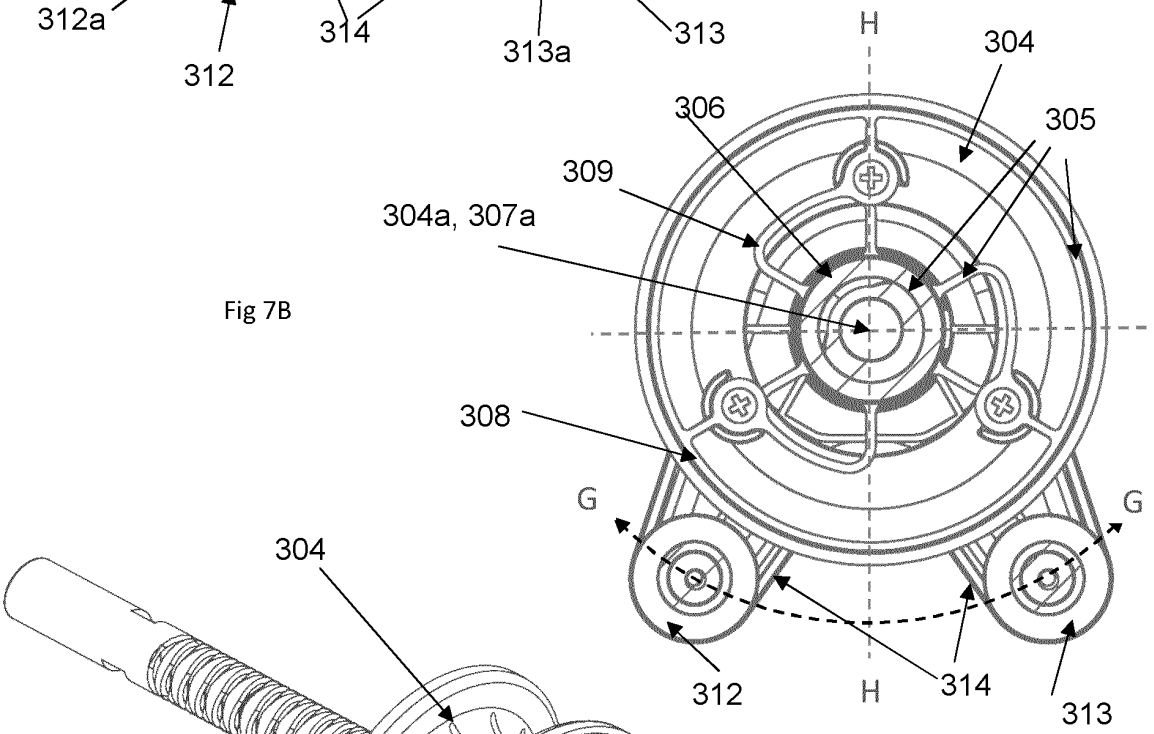
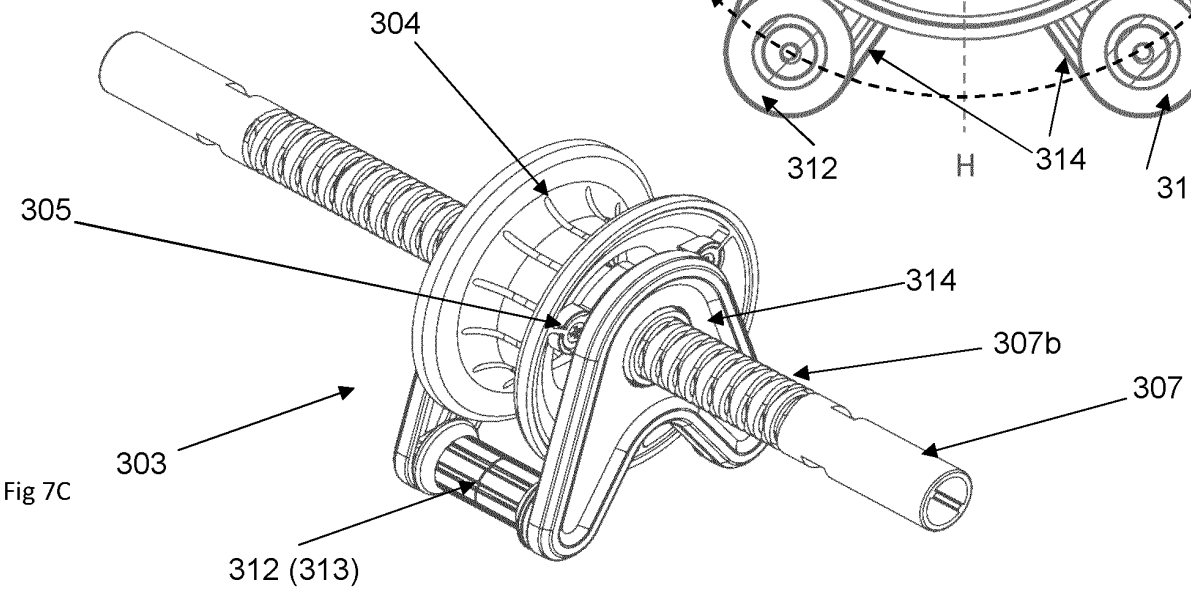


Fig 7C



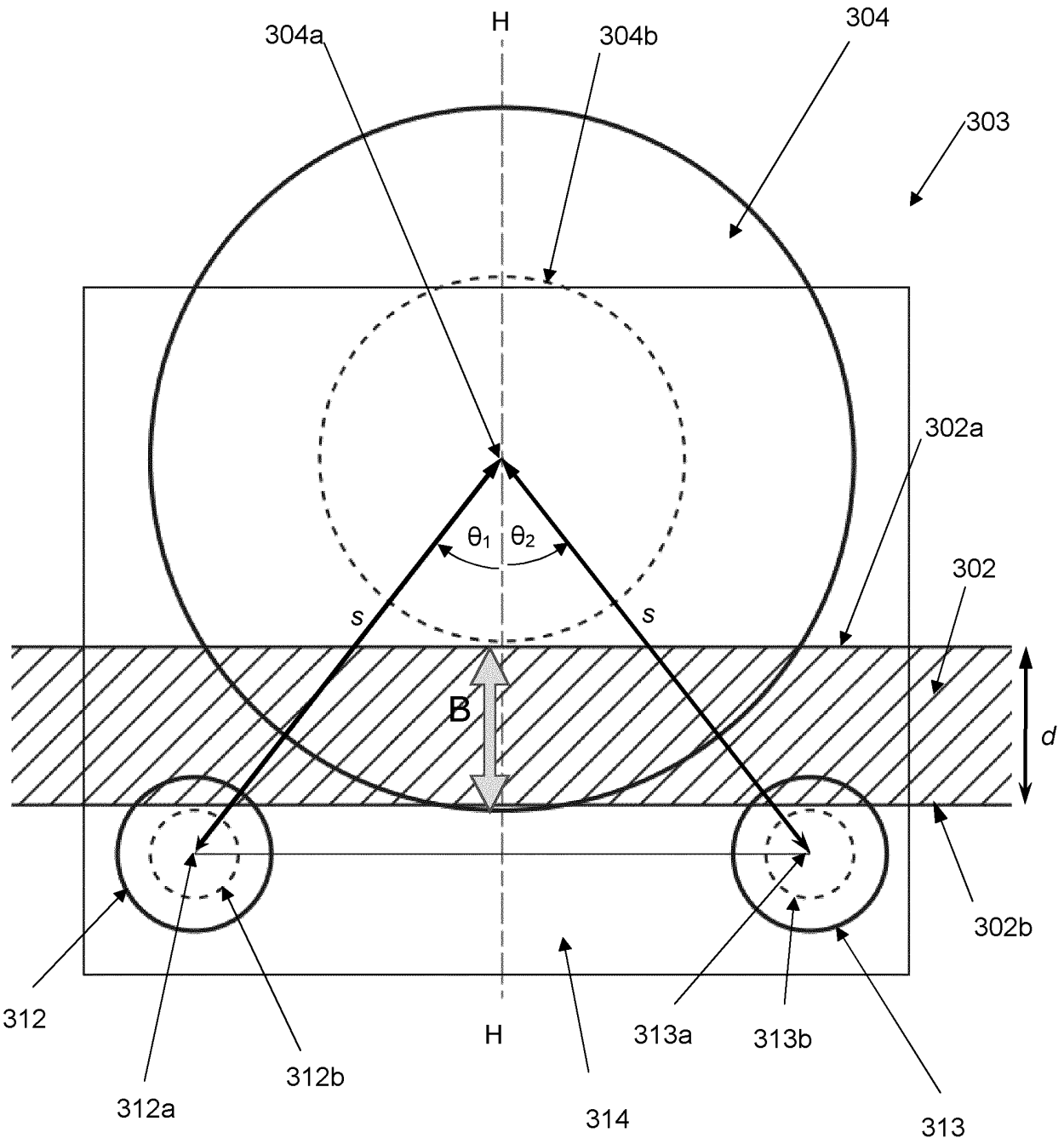

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Fig 8

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EUROPEAN SEARCH REPORT

Application Number
EP 22 21 2069

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	CN 111 232 766 A (DAISEN INFORMATION TECH HANGZHOU CO LTD) 5 June 2020 (2020-06-05) * paragraph [0013] - paragraph [0015] * * paragraph [0033] - paragraph [0034] * * figure 1 *	1,2,7,8, 13-15 9-12 3-6	INV. B65H57/00 B65H75/44
Y	CN 213 568 851 U (NINGBO DAYE GARDEN IND CO LTD) 29 June 2021 (2021-06-29) * figures 1-3 *	9-12	
Y	US 7 108 217 B2 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 19 September 2006 (2006-09-19) * figures 1-4 *	9-12	
A	CN 109 132 730 A (HUAIBEI SUOHUA MACHINERY EQUIPMENT CO LTD) 4 January 2019 (2019-01-04) * figures 1-3 * * paragraph [0022] - paragraph [0025] *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)
B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 May 2023	Guisan, Thierry

CATEGORY OF CITED DOCUMENTS

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10-05-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 111232766 A	05-06-2020	NONE	
CN 213568851 U	29-06-2021	CN 213568851 U	29-06-2021
		DE 202020105827 U1	16-02-2021
US 7108217 B2	19-09-2006	CN 1527682 A	08-09-2004
		DE 20110821 U1	11-10-2001
		EP 1404206 A1	07-04-2004
		HU 0400910 A2	28-07-2004
		KR 20040015292 A	18-02-2004
		MX PA03011827 A	26-03-2004
		PL 367138 A1	21-02-2005
		US 2004262443 A1	30-12-2004
		WO 03001960 A1	09-01-2003
CN 109132730 A	04-01-2019	NONE	

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