(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
03 September 2020 (03.09.2020)

WIPO | PCT

(10) **International Publication Number**
WO 2020/173799 A1

(51) **International Patent Classification:**
H02G 11/02 (2006.01) ***H01R 35/02*** (2006.01) ***F16L 3/01*** (2006.01)

(21) **International Application Number:** PCT/EP2020/054463

(22) **International Filing Date:** 20 February 2020 (20.02.2020)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
LU101140 28 February 2019 (28.02.2019) LU

(71) **Applicant: HITEC LUXEMBOURG S.A.** [LU/LU]; 49, rue du Baerendall, 8212 MAMER (LU).

(72) **Inventors: LEINER, Yves**; c/o HITEC LUXEMBOURG S.A., 49, rue du Baerendall, 8212 MAMER (LU). **IVANOV, Georgi**; c/o HITEC LUXEMBOURG S.A., 49, rue du Baerendall, 8212 MAMER (LU). **GUEVEL, Marc**; c/o HITEC LUXEMBOURG S.A., 49, rue du Baerendall, 8212 MAMER (LU).

(74) **Agent: ARONOVA S.A.**; 327, 12, avenue du Rock n'Roll, 4004 Esch-sur-Alzette (LU).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

WO 2020/173799 A1

(54) **Title:** ENERGY CHAIN ROUTING DEVICE FOR A REVOLUTE JOINT

(57) **Abstract:** An energy chain routing device for routing an energy chain between a first body and a second body capable of rotating one with respect to the other comprises: (a) a radially outer part and a radially inner part mounted coaxially about the axis of rotation on the first and second body, respectively, (b) a circumferential chain guide on the radially inner part, (c) a peripheral partition on the radially outer part, arranged opposite the circumferential chain guide, and (d) an energy chain reserve space on or in the first body. The circumferential chain guide and the peripheral partition define a winding space for winding the energy chain on the radially inner part. The peripheral partition has a passage for the energy chain to pass from the reserve space into the winding space or vice versa when the first body and the second body rotate relative to each other.

ENERGY CHAIN ROUTING DEVICE FOR A REVOLUTE JOINT

Field of the Invention

[0001] The invention generally relates to the routing of cables, wires, optical fibres, hoses, or the like, from a first body to a second body that can move, within certain limits, with respect to the first body. More specifically, the invention proposes a solution for routing an energy chain (also known as drag chain, cable carrier or cable chain) at a revolute joint having a finite rotation range. In the context of the present document, the term “revolute joint” designates a kinematic pair having one, rotational, degree of freedom. Specifically, as used herein, the term encompasses simple revolute joints, such as, e.g., a hinge joint, as well as compound joints that are kinematically equivalent to simple revolute joints, e.g. joints implemented with one or more roller and/or ball bearings.

Background of the Invention

[0002] International patent application WO 01/37375 A2 relates to a coupling device for connecting lines between relatively rotating members, in particular to a coupling device for directing the passage of lines between a non-rotating antenna base structure and a rotating antenna which provides increased rotational travel while minimizing stress on the lines. The application addresses a problem in the field of large rotating antennas, where there is a need for supplying the large number of lines, such as cables and hoses, between the steerable antenna and the non-moving base. The solution proposed is a coupling device that includes first and second relatively rotating members mounted about a common axis and first and second lines fixed between the first and second members. The first line is adapted to wrap around the first member in a first direction and around the second member in a second direction, opposite the first direction, the second line is adapted to wrap around the first member in the second direction and around the second member in the first direction. A guide is revolvably mounted to the first and second members for translating the first and second lines between the first member and the second member as the first and second members rotate relative to each other.

[0003] Energy chains are guides designed to surround and protect flexible cables, wires, optical fibres, hoses, or the like, on moving machinery components. Energy chains can be configured to accommodate different types of movement while limiting flexure in terms of bending radius and/or direction(s) of flexure. Various types of energy chains are described in the literature and/or available on the market. An example of an energy chain is described in WO 2016/207132 A1.

[0004] WO 2011/086198 A2 discloses a cable routing device for receiving and guiding power lines or supply lines in a circular motion between two connecting points that can be moved relative to one another and to a sliding body. The cable routing device has a circular arc-shaped body and a routing space for the cables. The basic shape of the body is a flat, circular ring-shaped ribbon having one or more layers that in a provisioning position are wound helically about a centre line, wherein the ribbon comprises circumferential narrow sides and opposing larger sides, a first side and a second side, which connect said narrow sides. The first side is designed at least over a radial portion as an at least substantially continuous sliding surface. The routing space is arranged on the second side.

[0005] It is an object of an aspect of the present invention to provide a device for routing lines, e.g. cables and/or hoses, between relatively rotating members. The device may be used on any in particular to a coupling device for directing the passage of lines between a non-rotating antenna base structure and a rotating antenna which provides increased rotational travel while minimizing stress on the lines

Summary of the Invention

[0006] An aspect of the invention relates to an energy chain routing device for routing an energy chain between a first body and a second body capable of rotating one with respect to the other about an axis of rotation of a revolute joint. The chain routing device comprises

- a radially outer part and a radially inner part mounted coaxially about the axis of rotation on the first and second body, respectively,
- a circumferential chain guide on the radially inner part,
- a peripheral partition on the radially outer part, arranged opposite the circumferential chain guide, and
- an energy chain reserve space on or in the first body (stationary with respect to the radially outer part).

The circumferential chain guide and the peripheral partition define between them a winding space for winding the energy chain on the radially inner part. The peripheral partition has a passage therein for the energy chain to pass from the energy chain reserve space into the winding space or vice versa when the first body and the second body rotate relative to each other. The energy chain reserve space is preferably arranged farther away from the axis of rotation than the winding space and, accordingly, the passage is thus preferably configured and arranged to impart a radial motion component on the energy chain when it passes from the energy chain reserve space into the winding space or vice versa.

[0007] In a further aspect, the invention relates to a revolute joint comprising

- the first body and the second body capable of rotating one with respect to the other about an axis of rotation of the revolute joint, and
- the energy chain routing device for routing an energy chain between the first body and the second body.

[0008] The energy chain routing device preferably includes an energy chain for accommodating therein one or more cables or hoses. The winding space is preferably dimensioned in accordance with the dimensions of the energy chain so as to limit axial and radial movement of the energy chain. The energy chain is preferably capable of accommodating two-dimensional bending. Optionally, the energy chain could also be capable of torsional movements but there may be embodiments where torsion of the energy chain is not desired. An energy chain having a circular cross section may be preferable in certain embodiments of the invention. Nevertheless, other (e.g. oval, rectangular, or trapezoidal) cross sections are not excluded. Advantageously, the winding space limits the movements of the energy chain in the direction of the axis of rotation (axial movement) and away from or towards the axis of rotation (radial movement) to displacements not exceeding 30% (preferably less, e.g. 25%, 20%, 10%, 5% or even less) of the cross sectional diameter (i.e. the maximum extension in case of a non-circular cross section) of the energy chain.

[0009] By design, the energy chain has a nominal minimum bending radius. Preferably, the circumferential chain guide, the peripheral partition and the passage are dimensioned with bending radiuses greater than the nominal minimum bending radius in such a way that within the chain routing device, the energy chain has an actual minimum bending radius greater than the nominal minimum bending radius. More preferably, the circumferential chain guide, the peripheral partition and the passage are dimensioned with bending radiuses greater than 1.2 times the nominal minimum bending radius in such a way that within the chain routing device, the energy chain has an actual minimum bending radius greater than 1.2 times the nominal minimum bending radius. It will thus be appreciated that the energy chain routing device may be configured such that an additional margin compared to the nominal minimum bending radius of the cable chain can be provided. Therefore a larger bending radius than what is provided by the cable chain alone could be guaranteed when necessary. There are specific types of cables (e.g. coaxial cables) or tubes that require larger bending radii than the nominal minimal bending radii of commercially available cable chains and this could be ensured with the routing device.

[0010] The circumferential chain guide may comprise a first annular abutment face and a second annular abutment face arranged in parallel on the radially inner part and axially delimiting the winding space. The second annular abutment face preferably comprises an opening for leading the energy chain out of the winding space.

[0011] The second abutment face preferably comprises bent ends delimiting the opening. These bent ends ensure a minimum bending radius where the cable chain leaves the circumferential chain guide.

[0012] The first and second abutment faces could be provided by ribs protruding from the radially inner part. Alternatively, the first and second abutment faces could be the side surfaces of a recess in the radially inner part.

[0013] The peripheral partition could comprise a cylindrical portion and a neck portion defining the passage. Preferably, the cylindrical portion and the neck portion are connected by outwardly bent transition portions providing a smooth transition between the cylindrical portion and the neck portion. The bent transition portions ensure a minimum bending radius at the passage.

[0014] The circumferential chain guide could also be formed helical about the axis of rotation. The circumferential chain guide could be formed as a helical recess in the radially inner part or delimited by a helical rib protruding from the radially inner part. Preferably, the pitch of the helix amounts to 120% or less of the cross sectional diameter of the energy chain, in order to maximize the number of turns on a given axial length.

[0015] According to a preferred embodiment, the energy chain routing device comprises a carriage mounted translationally mobile in parallel to the axis of rotation on the first body, the carriage carrying a transition guide for guiding the energy chain between the winding space and the energy chain reserve space. The axial displacement of the carriage is synchronized with the helical circumferential chain guide in such a way that the transition guide dispenses the energy chain or takes it up always at the right axial position when the first and second bodies rotate one relative to the other.

[0016] To achieve this synchronization, the carriage is preferably mechanically engaged with the helical circumferential chain guide so as to be actuated linearly when the helical circumferential chain guide rotates relative to the second body. Alternatively, the carriage could be moved by an actuator controlled by an angular position or velocity sensor arranged so as to detect the orientation or the angular velocity of the second body relative to the first body.

[0017] Preferably, the energy chain routing device also comprises a retracting mechanism for retracting the cable chain into the energy chain reserve space when the cable chain is unwound from the winding space. The retracting mechanism could use the force of a spring (e.g. a spring-loaded reel) or gravity to retract the energy chain (retraction of the energy chain could be effected by its own weight, or by an additional load suspended from the energy chain). Alternatively, the retracting mechanism could comprise a reel synchronized with the relative rotation of the first and second bodies so as to dispense the energy chain at (about) the same speed as it is taken up in the winding space and vice versa. The synchronization of such a retracting mechanism could be effected by a mechanical gearing or by an actuator controlled by an angular position or velocity sensor arranged so as to detect the orientation or the angular velocity of the second body relative to the first body. The energy chain routing device could comprise a box or other casing containing and delimiting the energy chain reserve space.

[0018] A further aspect of the invention relates to an antenna mount comprising a revolute joint with an energy chain routing device as presented.

Brief Description of the Drawings

[0019] By way of example, preferred, non-limiting embodiments of the invention will now be described in detail with reference to the accompanying drawings, in which:

Fig. 1: is a schematic perspective view of an antenna arrangement comprising an energy chain routing device for routing an energy chain from a stationary body to a rotatable body.

Fig. 2: is a perspective view of an energy chain routing device according to a first preferred embodiment of the invention.

Fig. 3: is a perspective view of the radially inner part of the energy chain routing device of Fig. 2.

Fig. 4: is a perspective view of the radially outer part of the energy chain routing device of Fig. 2.

Fig. 5: is a perspective view of an energy chain routing device according to a second preferred embodiment of the invention.

Fig. 6: is an exploded-view drawing of the energy chain routing device of Fig. 5.

Detailed Description of Preferred Embodiments

[0020] Fig. 1 illustrates a directional antenna arrangement 10 comprising a rotatable support body 12 mounted on a stationary base structure 14. The antenna arrangement 10 further includes an energy chain routing device 16 for routing an energy chain 18 between the stationary base structure 14 and the rotatable support body 12. The rotatable support body 12 is capable of rotating with respect to the stationary base structure 14 about a vertical axis of rotation A. The energy chain routing device 16 provides for the passage of lines (e.g. cables and/or hoses), enclosed inside the energy chain 18, between the non-rotating antenna base structure 14 and the rotating support body 12 while protecting the lines against excessive flexure, tension and friction.

[0021] Figs. 2 to 4 are more detailed illustrations of the energy chain routing device 16. The device 16 comprises a radially outer part 19 mounted fix on the stationary base structure 14 and a radially inner part 20 fixed to the rotatable support body 12.

[0022] The radially inner part 20 has a circumferential chain guide 22 arranged about it. The circumferential chain guide 22 includes a continuous lower annular rib 24 and an upper annular rib 26 sufficiently spaced from one another to accommodate between them the energy chain 18. The upper annular rib 26 has an opening 28 for leading the energy chain 18 out of the interstice between the ribs 24, 26, and further on the rotatable support body 12.

[0023] The radially outer part 19 of the energy chain routing device 16 comprises a peripheral partition 30, arranged opposite the circumferential chain guide 22, in such a way that an annular winding space 32 is defined between the circumferential chain guide 22 and the peripheral partition 30. The peripheral partition 30 has a passage 34 therein, allowing the energy chain 18 to pass from an energy chain reserve space 36, provided in or on the stationary base structure 14, into the winding space or vice versa when the rotatable support body 12 rotates relative to the stationary base structure 14. The peripheral partition 30 comprises a cylindrical portion 42 describing an almost full circle and a neck portion 44 defining the passage 34, the cylindrical portion 42 and the neck portion 44 being connected by outwardly bent transition portions 46. Within the neck portion, the peripheral portion comprises a downwardly curved slide 48 for supporting the energy chain when it transits through the passage 34. At its radially outer end, the neck portion 44 features outwardly curved guide rail terminations 50.

[0024] The energy chain 18 is fixed to the rotatable support body 12 by a first mounting bracket 38 and to the stationary base structure 14 by a second mounting bracket 40. There is a fixed length of energy chain 18 between the first and second mounting brackets 38, 40.

[0025] Fig. 2 shows the energy chain routing device 16 in the neutral position, wherein the passage 34 and the opening 28 are facing each other and the energy chain passes directly from the passage 34 into the opening 28. When the rotatable support body 12 and thus the radially inner part is rotated out of the neutral position (in either direction), the energy chain 18 is dragged into the winding space 32 and wound up on the radially inner part of the energy chain routing device 16. When the rotatable support body 12 and thus the radially inner part is rotated back to the neutral position, the energy chain 18 is retracted into the energy chain reserve space 36, e.g. by gravity (as illustrated in Fig. 1) or by a retracting mechanism.

[0026] It is worthwhile noting that any length of energy chain that is wound-up on the radially inner part 20 is supported by the lower rib 24 and rotates with it essentially without slippage. Accordingly, wear of the energy chain is reduced.

[0027] The dimensions of the winding space 32 are selected so as to limit axial and radial movement of the energy chain 18. The inner surfaces of the ribs 24, 26 serve as abutment surfaces restricting the energy chain in the axial direction, while the inner surface of the peripheral partition serves as a delimiter for radial movements of the energy chain. In the illustrated embodiment, the cross section of the winding space is approximately quadratic, with a side length slightly (e.g. up to 20%) greater than the diameter of the energy chain 18. However, it will be understood that one may opt for a different shape of the winding space especially if an energy chain with a non-circular cross section should be employed.

[0028] In the embodiment of Figs. 2-4, the peripheral partition 30 is symmetrical about the median plane of its passage 34. Likewise, the circumferential chain guide 22 is symmetrical about the median plane of the opening 28. Thanks to this symmetrical configuration, the rotatable support body 12 can be rotated out of the neutral position in either direction. In the illustrated embodiment, the angular range of the rotary joint can be from -360° to +360° (i.e. two full turns) provided that there is sufficient energy chain length that can travel between the energy chain reserve space 36 and the winding space 32 and the angular range is not otherwise limited.

[0029] Figs. 5 and 6 illustrates another embodiment of an energy chain routing device 116. The device 116 comprises a radially outer part 119 mounted fix on the stationary base structure 114 and a radially inner part 120 fixed to the rotatable support body (not shown).

[0030] The radially inner part 120 has a circumferential chain guide 122 in the form of a helix. The circumferential chain guide 122 includes a helical rib with a pitch sufficient to accommodate the energy chain (not shown) between two neighbouring windings of the rib. At one end of the circumferential chain guide 122, a mounting bracket 138 is fixed on the radially inner part 120 to secure the energy chain thereto.

[0031] The radially outer part 119 of the energy chain routing device 116 comprises a peripheral partition 130 (see Fig. 6), arranged opposite the circumferential chain guide 122, in such a way that a helical winding space 132 is defined between the circumferential chain guide 122 and the peripheral partition. The peripheral partition 130 has a passage 134 therein, allowing the energy chain to pass from an energy chain reserve space, provided in or on the stationary base structure 114, into the winding space 132 or vice versa when the rotatable support body rotates relative to the stationary base structure 114. The peripheral partition 130 comprises a cylindrical portion 142 having a slit therein that defines the passage 134. The height of the passage corresponds (at least approximately) to the height of the helical circumferential chain guide 122.

[0032] The energy chain routing device 116 further comprises a carriage 152 mounted translationally mobile on the stationary base structure 114 in parallel to the axis of rotation of the rotatable support body. The carriage 152 carries a transition guide 154 for guiding the energy chain between the winding space 132 and the energy chain reserve space. The axial displacement of the carriage 152 is synchronised with the helical circumferential chain guide 122 by means of a wheel assembly 156. The wheel assembly 156 comprises a set of wheels (a running wheel 158 and an up-stop wheel 159) hugging the helical rib forming the circumferential chain guide 122. When the rotatable support body (and thus the radially inner radially inner part 120 with the helical circumferential chain guide 122) rotates relative to the stationary base structure 114, the wheel assembly 156 urges the carriage 152 into a linear movement parallel to the axis of rotation, whereby it is ascertained that the energy chain is dispensed or taken up always at the right axial position.

[0033] The number of turns of the helix determines the angular range of the rotary joint provided that there is sufficient energy chain length that can travel between the energy chain reserve space and the winding space 132 and the angular range is not otherwise limited.

[0034] Regarding the energy chain reserve space, it may be of the same configuration as in the embodiment described previously. A retracting mechanism using gravity or the force of a spring could be employed. Alternatively, the retracting mechanism could be synchronized with the rotatable support body so as to dispense the energy chain at (about) the same speed as it is taken up in the winding space and vice versa.

[0035] The dimensions of the winding space 132 are selected so as to limit axial and radial movement of the energy chain. The side surfaces of the helical rib serve as abutment surfaces restricting the energy chain in the axial direction, while the inner surface of the peripheral partition 130 serves as a delimiter for radial movements of the energy chain.

[0036] While specific embodiments have been described herein in detail, those skilled in the art will appreciate that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the invention, which is to be given the full breadth of the appended claims and any and all equivalents thereof.

Claims

1. An energy chain routing device for routing an energy chain between a first body and a second body capable of rotating one with respect to the other about an axis of rotation of a revolute joint, comprising
a radially outer part and a radially inner part mounted coaxially about the axis of rotation on the first and second body, respectively,
a circumferential chain guide on the radially inner part,
a peripheral partition on the radially outer part, arranged opposite the circumferential chain guide, and
an energy chain reserve space on or in the first body,
the circumferential chain guide and the peripheral partition defining between them a winding space,
the peripheral partition having therein a passage for the energy chain to pass from the energy chain reserve space into the winding space or from the winding space into the energy chain reserve space when the first body and the second body rotate relative to each other.

2. The energy chain routing device as claimed in claim 1, comprising an energy chain for accommodating therein one or more cables or hoses, wherein the winding space is dimensioned to limit axial and radial movement of the energy chain.

3. The energy chain routing device as claimed in claim 2, wherein the energy chain has a nominal minimum bending radius and wherein the circumferential chain guide, the peripheral partition and the passage are dimensioned with bending radiuses greater than said nominal minimum bending radius in such a way that within the chain routing device, the energy chain has an actual minimum bending radius greater than said nominal minimum bending radius.

4. The energy chain routing device as claimed in claim 3, wherein the circumferential chain guide, the peripheral partition and the passage are dimensioned with bending radiuses greater than 1.2 times said nominal minimum bending radius in such a way that within the chain routing device, the energy chain has an actual minimum bending radius greater than 1.2 times said nominal minimum bending radius.

5. The energy chain routing device as claimed in any one of claims 1 to 4, wherein the circumferential chain guide comprises a first annular abutment face and a second annular abutment face arranged in parallel on the radially inner part and axially delimiting the winding space, the second annular abutment face comprising an opening for leading the energy chain out of the winding space.

6. The energy chain routing device as claimed in claim 5, wherein the second abutment face comprises bent ends delimiting the opening.

7. The energy chain routing device as claimed in claim 5 or 6, wherein the first and second abutment faces are provided by ribs protruding from the radially inner part.

8. The energy chain routing device as claimed in claim 5 or 6, wherein the first and second abutment faces delimit a recess in the radially inner part.

9. The energy chain routing device as claimed in any one of claims 1 to 8, wherein the peripheral partition comprises a cylindrical portion and a neck portion defining the passage, the cylindrical portion and the neck portion being connected by outwardly bent transition portions.

10. The energy chain routing device as claimed in any one of claims 1 to 4, wherein the circumferential chain guide is helical about the axis of rotation.

11. The energy chain routing device as claimed in claim 10, wherein the circumferential chain guide is formed as a helical recess in the radially inner part or delimited by a helical rib protruding from the radially inner part.

12. The energy chain routing device as claimed in claim 10 or 11, comprising a carriage mounted translationally mobile in parallel to the axis of rotation on the first body, the carriage carrying a transition guide for the energy chain between the winding space and the energy chain reserve space, wherein an axial displacement of the carriage is synchronised with the helical circumferential chain guide.

13. The energy chain routing device as claimed in claim 12, wherein the carriage is mechanically engaged with the helical circumferential chain guide so as to be actuated linearly when the helical circumferential chain guide rotates relative to the second body

14. The energy chain routing device as claimed in any one of claims 1 to 13, comprising a retracting mechanism configured to retract the cable chain into the energy chain reserve space when the cable chain is unwound from the winding space.

15. An antenna mount comprising a revolute joint and an energy chain routing device as claimed in any one of claims 1 to 14.

Fig. 1

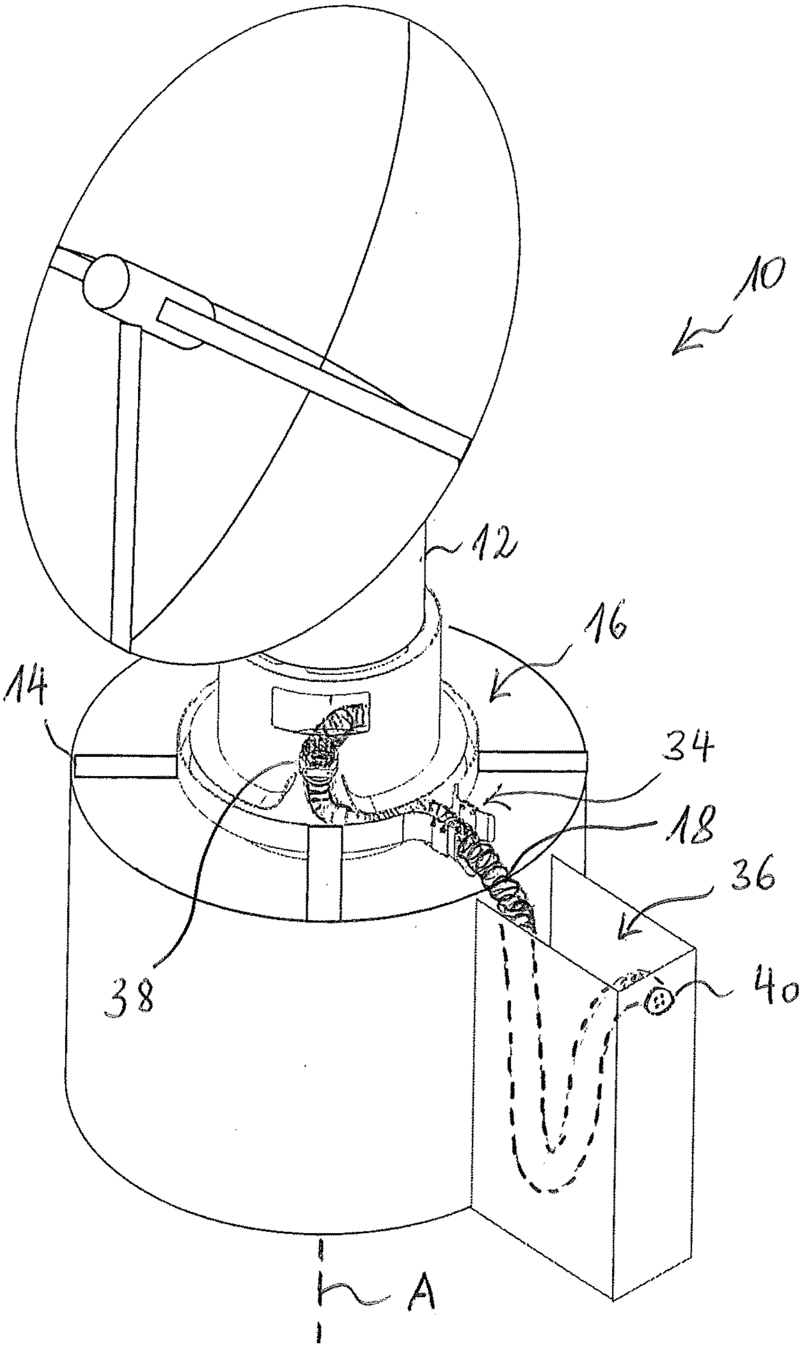


Fig. 2

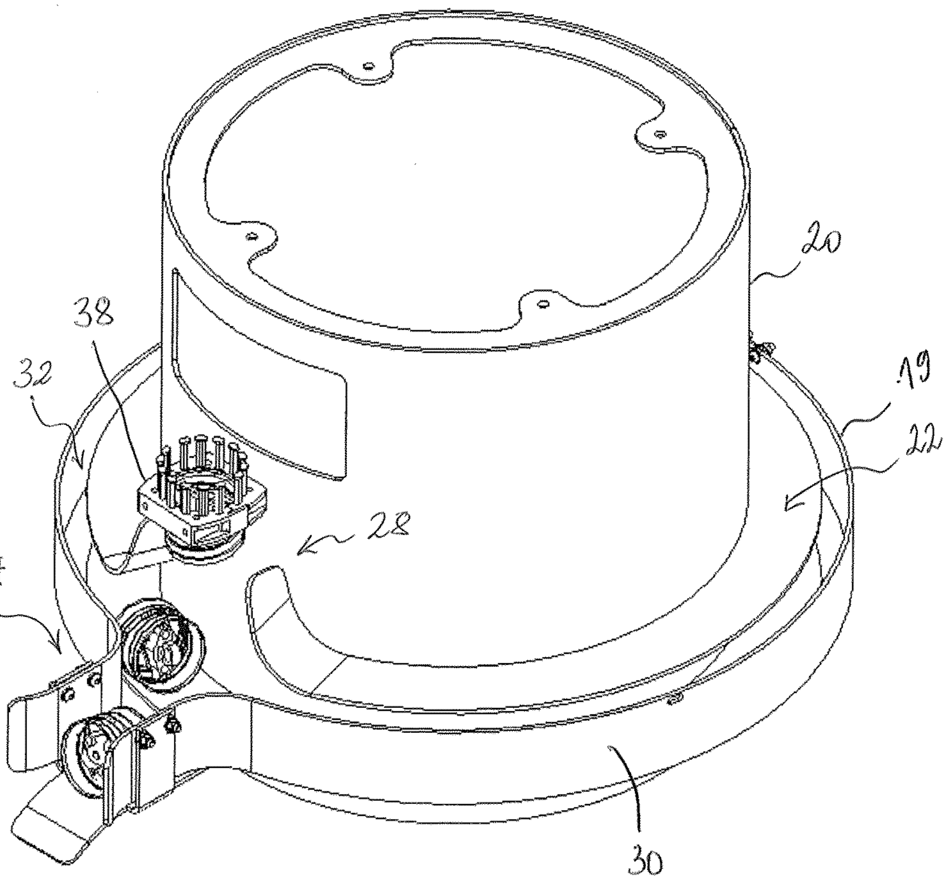


Fig. 3

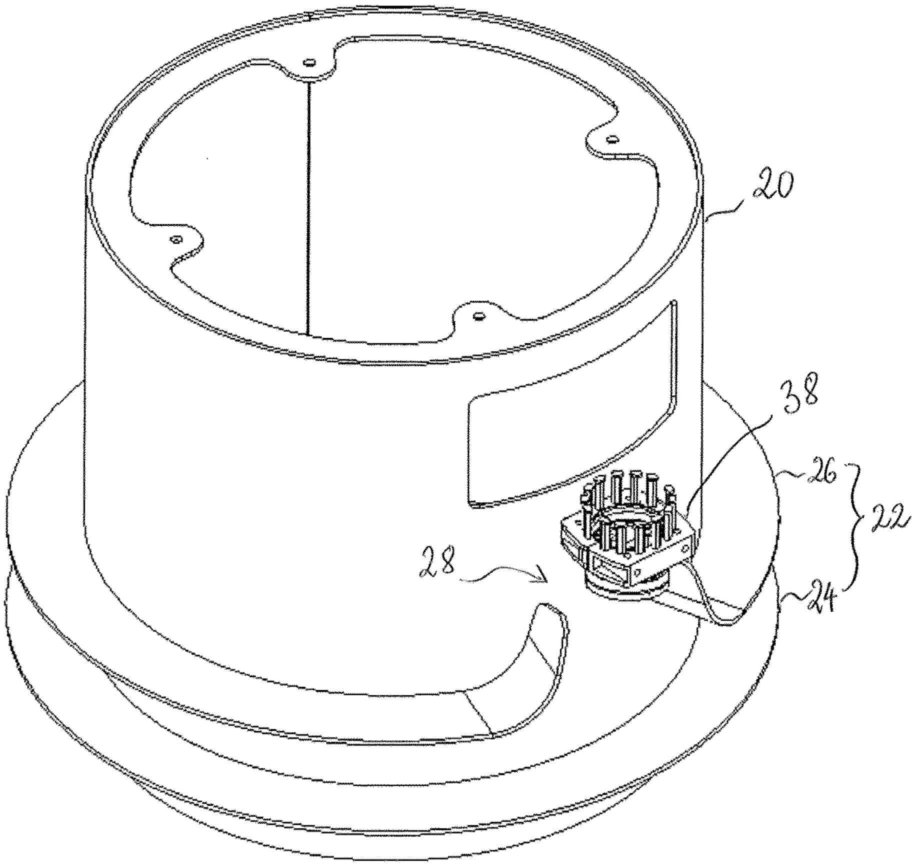


Fig. 4

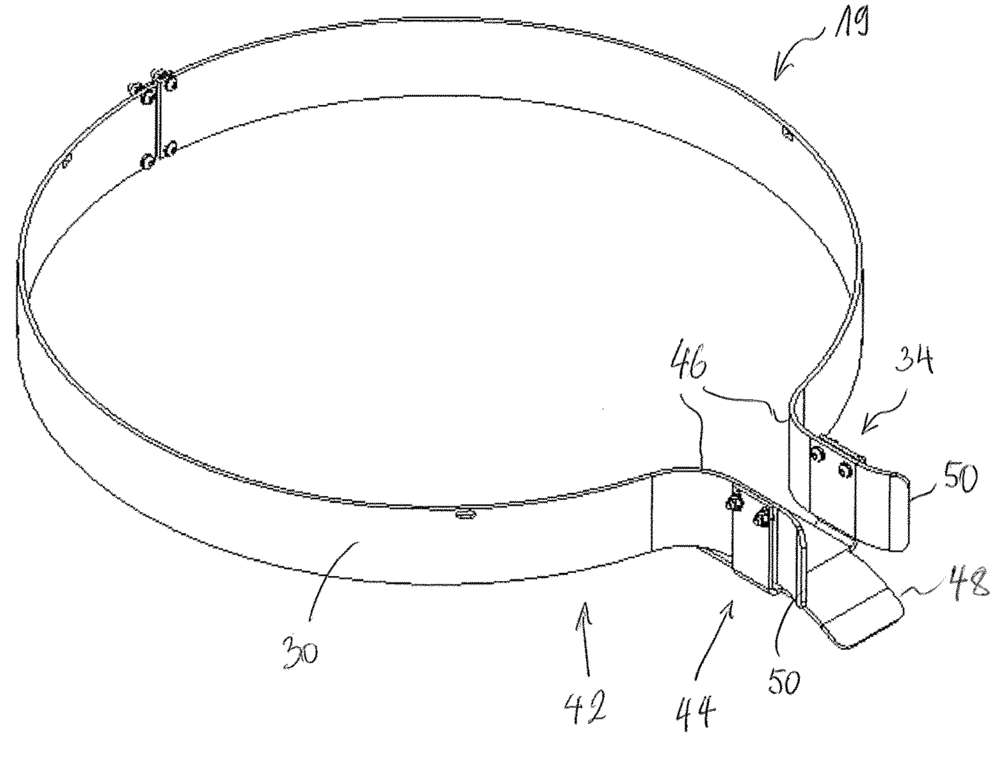


Fig. 5

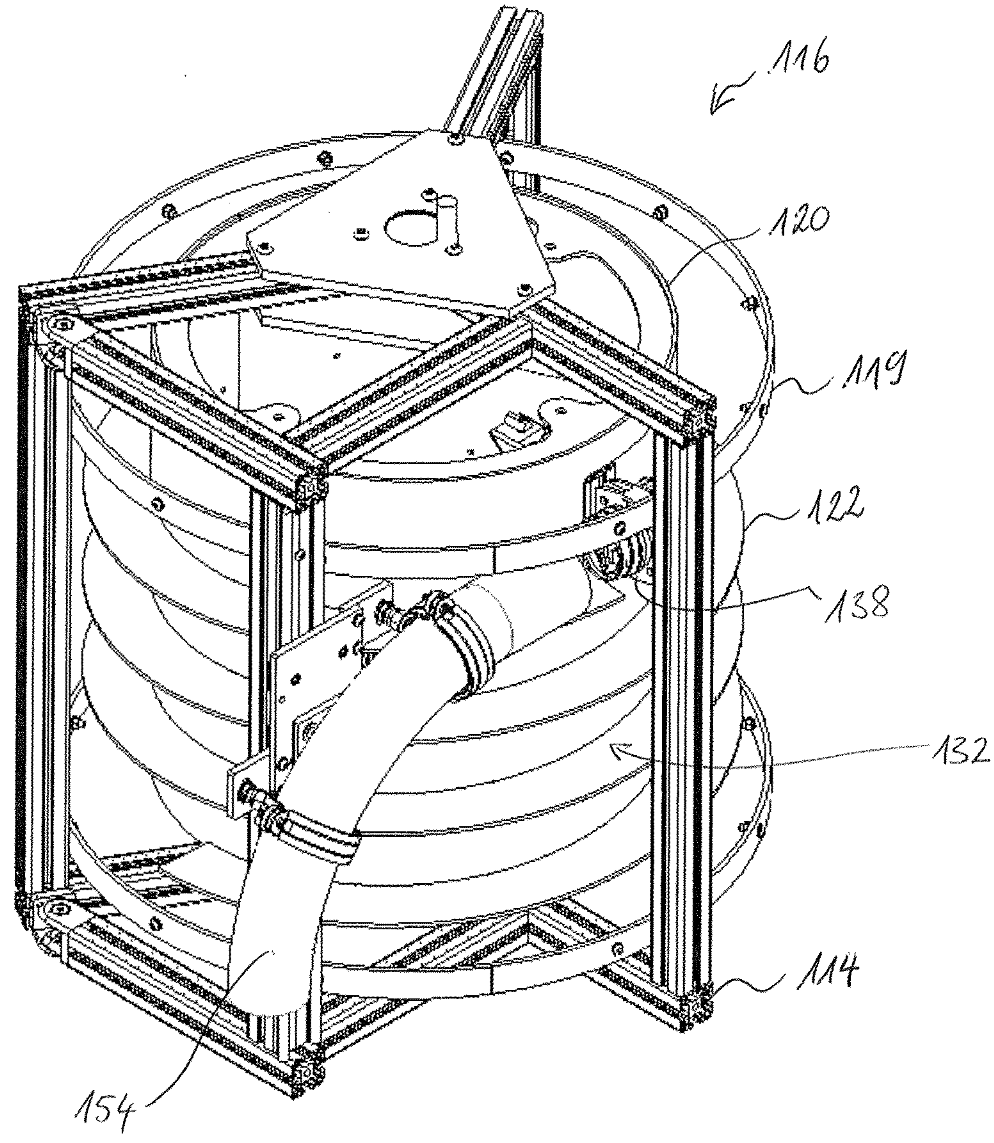
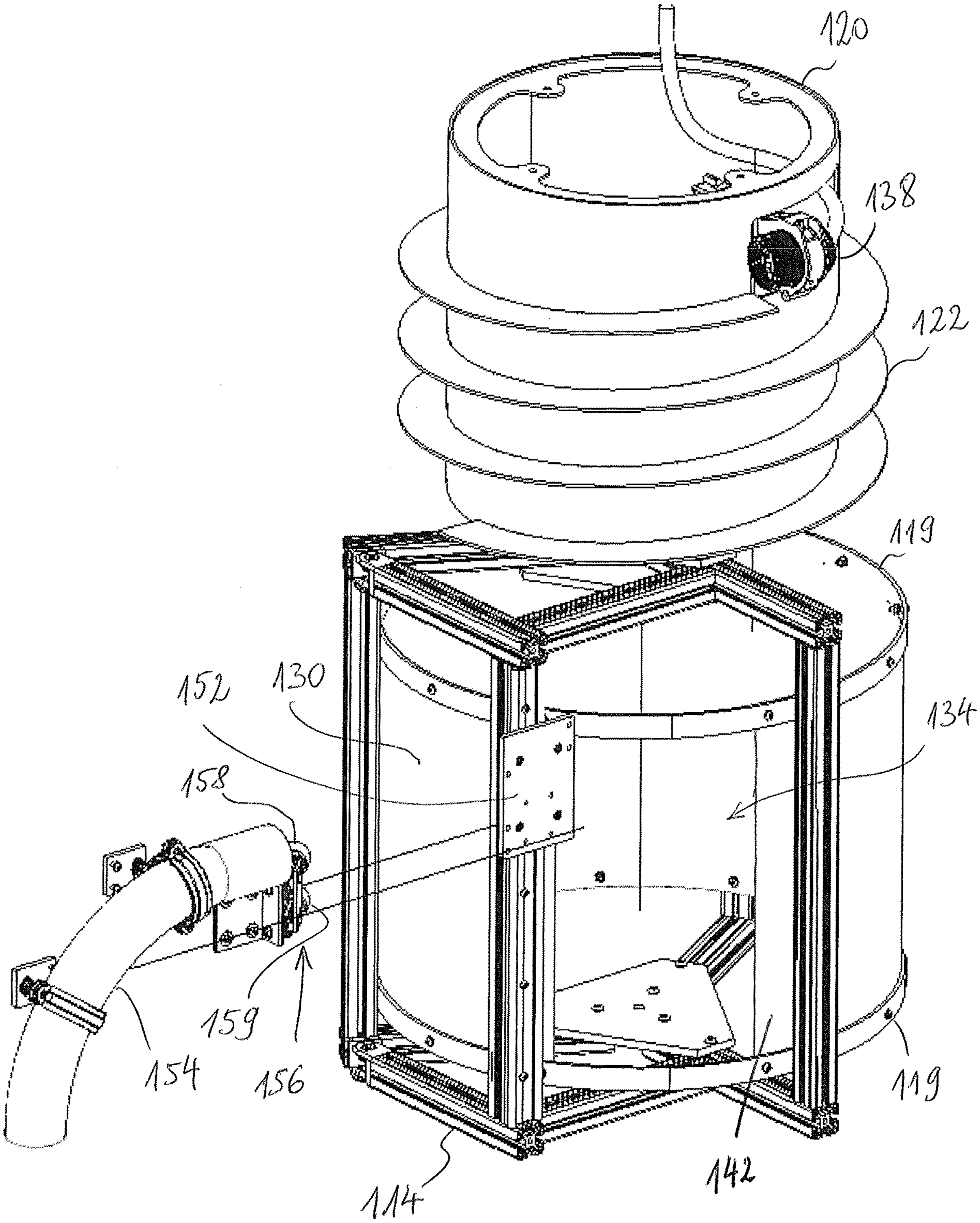


Fig. 6



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/054463

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02G11/02 F16L3/01 H01R35/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02G F16L H01P H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE 10 2016 204832 B3 (SIEMENS HEALTHCARE GMBH [DE]) 10 August 2017 (2017-08-10) paragraphs [0040] - [0044]; figures 1-4	1-5,7-9, 15 10,11,14
Y	WO 01/37375 A2 (RAYTHEON CO [US]) 25 May 2001 (2001-05-25) abstract; figure 1	10,11
Y	US 2015/325994 A1 (CIAMPA ANTOINE [CA] ET AL) 12 November 2015 (2015-11-12) paragraph [0047]	14
A	US 3 909 047 A (SALMELA GORDON O) 30 September 1975 (1975-09-30) abstract; figures 1-5	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 April 2020	07/05/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Buccafurri, Emanuela

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2020/054463

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102016204832 B3	10-08-2017	CN 207542756 U	26-06-2018
		DE 102016204832 B3	10-08-2017
		US 2017280541 A1	28-09-2017
WO 0137375 A2	25-05-2001	AU 4610501 A	30-05-2001
		US 6361237 B1	26-03-2002
		WO 0137375 A2	25-05-2001
US 2015325994 A1	12-11-2015	US 2015325994 A1	12-11-2015
		US 2015325995 A1	12-11-2015
		US 2015325996 A1	12-11-2015
		WO 2015168770 A1	12-11-2015
US 3909047 A	30-09-1975	NONE	