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(54) ## TRANSMISSION SYSTEM FOR OSCILLATING SYSTEMS AND STEERABLE ANTENNA COMPRISING SAID TRANSMISSION SYSTEM

(57) A transmission system (100) for oscillating systems is described, comprising:
-a drive pulley (110) operable in rotation about an axis of rotation of the drive pulley;
-a driven pulley (120);
-a first and a second flexible transmission element (130A, 130B) operatively coupled to the drive pulley (110) and the driven pulley (120) for the transmission of a movement between said pulleys (110, 120), the first and second flexible transmission elements (130A, 130B) each comprising a first and a second connection portion (131A, 131B, 132A, 132B), each of said first connection portions (131A, 131B) being attached to the drive pulley (110); and
-a connection element (36) to connect the transmission system (100) to a payload (4, 5) the connection element (36) being integral in rotation with the driven pulley (120) around an axis of rotation.
the drive pulley (110) is adapted to drag the driven pulley (120) and the connection element (36) in rotation in a first and in a second direction of rotation opposite to each other respectively by means of the first and second flexible transmission elements (130A, 130B).

The transmission system (100) is characterised in that:
-the connection element (36) is arranged to rotate around the axis of rotation of the drive pulley (110);
-comprises a fixed part (150) with respect to said drive and driven pulleys (110, 120), said second connection portions (132A, 132B) being attached to said fixed part (150) ;
-said rotation axis around which the driven pulley (120) and the connection element (36) are integral in rotation is the axis of rotation of the drive pulley (110).

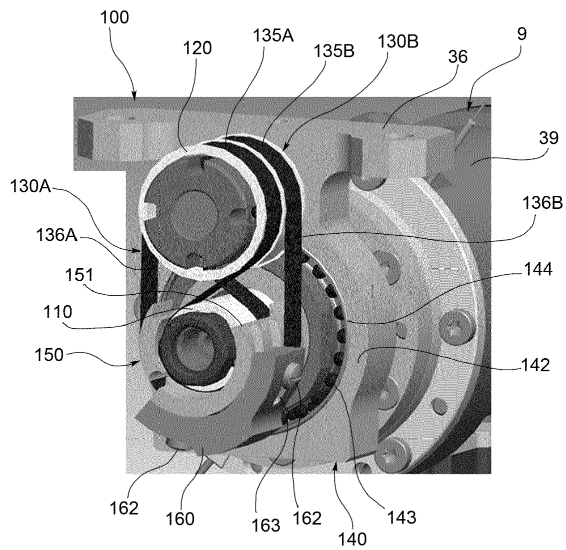

FIG. 7

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Description

[0001] This description refers to a transmission system for oscillating systems and to a steerable antenna comprising said transmission system.

[0002] With reference for example and not limitedly to the field of servo-assisted kinematic movement systems used in the missile field (gimbals), there is often the problem of transmitting motion to a payload, which in the specific case typically comprises a radio frequency (RF) antenna, so as to ensure extreme precision in aiming, high angular accelerations, absolute absence of slack within the entire kinematic chain, even under external disturbances, such as vibrations from free flight and shock of departure and manoeuvring.

[0003] The kinematic chains used for these purposes are of different types, each with its peculiarities, advantages and disadvantages. In the case in which the transmission ratio is direct, these kinematic mechanisms have either direct connections to the motor shafts suitable to allow the movement of the payload or rigid intermediate mechanical controls of various types.

[0004] In cases in which the upstream torque is not sufficient to ensure the angular accelerations required, it is necessary to resort to mechanisms with transmission ratios.

[0005] For this purpose, mechanics provides various solutions, such as belt and pulley transmissions and gears, among others.

[0006] In the case of servomechanisms for high-performance missile aiming gimbals, to the simple reduction function are additional complications due to the need to ensure an almost absolute uniqueness of the transmission position (not obtainable with elastically deformable transmission elements such as transmission belts, or slipping transmission elements such as contact pulleys), an almost absolute absence of slack (not obtainable with standard gear of chain transmission), low friction and low resistive torque (not always obtainable from the above-mentioned classical systems).

[0007] A type of the transmission system of the known technique suitable to provide the general requirements of stiffness, uniqueness of transmission, the absence of slack and low friction allowing the satisfaction, at least partly, of the aforesaid need, is represented by a pulley and metal band transmission system. In practice, such a transmission system is based on a transmission that is mechanically similar to a rigid belt (metal band) transmission system that interfaces on non-contact mobile and fixed pulleys.

[0008] In a system of pulleys and bands, simple mechanical elements are used such as pulleys and metal bands, the latter being typically made of harmonic steel. The bands appear to be ribbons of steel whose purpose is to transfer the motion from the drive pulley to the driven one.

[0009] The motion is thus transferred from the band whose rigidity to this stress is such as to be considered rigid and with deformations such as not to be comparable with the precision required.

[0010] In its simplest embodiment, a pulley and metal band transmission system of the above-mentioned type comprises a drive pulley, a driven pulley to which is integral a connection element (such as, for example, a connection flange) for connecting the transmission system to a payload, and a pair of metal bands. Specifically, the drive pulley and the driven pulley are suitable to each rotate around a respective fixed rotation axis. The two bands each have one end fixed to the drive pulley and an opposite end fixed to the driven pulley and are disposed so as to cross in the space between the drive pulley and the driven pulley. When the drive pulley rotates around the respective rotation axis, the driven pulley and the connection element integral to it are driven in rotation by the bands around the rotation axis of the driven pulley. During the rotation of the drive pulley, pulling is ensured only by one of the two bands, i.e., the band that works in traction.

[0011] A drawback of this type of pulley and band transmission system is represented by the fact that such a transmission system is relatively bulky. This drawback is particularly relevant in the case in which the space available for the installation of the transmission system is particularly reduced, as happens for example and not limitedly in the case in which the transmission system is to be installed in the radome of a missile.

[0012] A general purpose of this description is to make available a transmission system for oscillating systems that is able to solve, at least partly, the drawback described above with reference to the known art.

[0013] This and other purposes are achieved through a transmission system as defined in the main claim in its most general form, and in the dependent claims in several particular embodiments.

[0014] This invention also covers a transmission group as defined in claim 10.

[0015] This invention also covers a steerable antenna as defined in claim 11.

[0016] This invention also covers a seeker as defined in claim 15.

[0017] The invention will be better understood from the following detailed description of its embodiments, provided by way of example and therefore in no way limiting, in relation to the accompanying drawings, wherein:

- Figure 1 shows a perspective view in partial section of a portion of a missile, comprising a radome and a steerable antenna;
- Figure 2 shows a perspective view of the steerable antenna of Figure 1;
- Figure 3 shows a first view in lateral section of the steerable antenna of Figure 1;
- Figure 4 shows a perspective view of an embodiment of a support bracket of the steerable antenna of Figure 1;
- Figure 5 shows a second view in lateral section of

the steerable antenna of Figure 1, in which the section plane is perpendicular to the section plane of the view of Figure 3;

- Figure 6 shows a perspective view of an enlarged detail of the steerable antenna of Figure 1;
- Figure 7 shows a partial perspective view of a transmission group comprising a transmission system according to a presently preferred embodiment and a motor, this transmission group being represented in a first configuration and being suitable to be mounted in the steerable antenna of Figure 1;
- Figure 8 shows a partial perspective view of the group of Figure 7 in which the transmission system is shown partially in section;
- Figure 9 shows a partial perspective view of the group of Figure 7 represented in a second configuration;
- Figure 10 shows a partial perspective view in section of the transmission group of Figure 7;
- Figure 11 shows a perspective view of a component of the transmission system of Figure 7; and
- Figure 12 shows a schematic and partial plan view of the transmission system of Figure 7, in which said transmission system is represented in a plane orthogonal to the rotation axis of the respective drive pulley.

[0018] In the annexed figures, equal or similar elements will be indicated by the same reference numbers.

[0019] Note that the terms "axial", "radial" and "circumferential" used to describe the structure or functioning of a transmission system according to this description, or of its parts, are to be understood to refer to the rotation axis of a drive pulley of this transmission system.

[0020] Figure 1 shows a portion of an embodiment of a missile 1 comprising a radome 2 and a steerable antenna 3 mounted inside the radome 2. In the particular example represented and without thereby introducing any limitation, the steerable antenna 3 is the antenna of a radar and more particularly the antenna of a missile seeker. It should be noted, however, that the teachings of this description are applicable without limitations regarding the particular type of steerable antenna, since the steerable antenna of this description could be any antenna usable for example in the fields of telecommunications, terrestrial or satellite, and scientific measurement instrumentation.

[0021] The steerable antenna 3 comprises a payload 4,5, preferably an orientable payload 4,5. For example, the orientable payload 4,5 comprises at least one receiver and/or transmitter device of electromagnetic radiations 4. For example, the receiver and/or transmitter device of electromagnetic radiations 4 comprises a planar array antenna for example a microwave disc antenna comprising a plurality of antenna elements, for example patch antenna elements or slot antenna elements. Preferably, and without thereby introducing any limitation, receiver and/or transmitter device of electromagnetic radiations 4 is both a receiving and transmitting device.

[0022] According to an embodiment, the payload 4,5 also comprises a processing circuit section 5 of the signals transmitted and/or received by the receiver and/or transmitter device of electromagnetic radiations 4.

[0023] According to a preferred embodiment, the steerable antenna 3 also comprises an electromechanical movement and support system 6-10 operatively connected to the payload 4,5 and suitable to orient the payload 4,5 in a controlled manner.

[0024] According to a preferred embodiment, the electromechanical movement and support system 6-10 comprises a base 6 and preferably a first motor 7 (or external motor 7) fixed to the base 6. Preferably, the electromechanical movement and support system 6-10 comprises a first driven pulley 8 operatively coupled to the first motor 7 to be rotated about a first rotation axis (or external rotation axis). According to an embodiment, the steerable antenna 3, and more preferably the electromechanical movement and support system 6-10 comprises a second motor 9 (or internal motor 9). According to an embodiment, the second motor 9 is operatively coupled to the first driven pulley 8 and operatively connected to the payload 4,5 to rotate the payload 4,5 about a second rotation axis (or internal rotation axis). The first and the second rotation axis are perpendicular to each other.

[0025] The electromechanical movement and support system 6-10 also includes a support bracket 10, for example as represented in Figure 3, integral with the base 6 and to which is pivotally hinged to the second motor 9.

[0026] The first driven pulley 8 is operatively connected to the second motor 9 to rotate the second motor 9 with respect to the base 6 and with respect to the support bracket 10.

[0027] Preferably, the first 7 and the second 9 motor are servomotors.

[0028] According to an embodiment, the base 6 it is a container of cylindrical shape, or substantially cylindrical provided with a first opening 12 or top opening 12 and a lower opening 13 or second opening 13. Preferably, the base 6 comprises a housing 14 inside which the first motor 7 is housed and fixed. Preferably, the steerable antenna 3 comprises an electronic control circuit 15 of the first motor 7 also housed at least partially in the housing 14.

[0029] According to an embodiment, the base 6 comprises one or more fixing elements 16 suitable to allow the fixing of the base 6 inside the radome 2. For example, these fixing elements 16 comprise a plurality of recesses defined on the outer side walls of the base 6.

[0030] According to an embodiment, the upper opening 12 of the base 6 allows the passage of at least one transmission element of the motion from the first motor 7 to the first driven pulley 8.

[0031] With reference to Figure 4, according to an embodiment, the support bracket 10 comprises a first end portion 20,21 solidly fixed to the base 6 and a second end portion 22,23 to which the second motor 9 is pivotally hinged. For example, the first end portion 20,21 is fixed to the base by means of screws that cross through-openings provided in the first end portion 20,21 to be inserted into corresponding internally threaded openings or holes provided in the upper wall of the base 6.

[0032] Preferably, the support bracket 10 is fork-shaped, and the second end portion 22,23 comprises two end portions between which the second motor 9 is pivotally hinged.

[0033] More preferably, the said first end portion 20,21 of the support bracket 10 comprises at least one foot for fixing to the base 6 provided with a through-opening 26 crossed by the first driven pulley 8 and not interfering with the rotation of the driven pulley 8. In the example of Figure 3, the aforesaid fixing foot 20,21 comprises two fixing feet 20,21 spaced apart and between which is defined the aforesaid through-opening 26 crossed by the first driven pulley 8.

[0034] According to a further embodiment, the support bracket 10 comprises two fork arms 24,25 fixed to the fixing foot 20,21 of the support bracket 10 and the aforesaid second end portions 22,23 are free end portions of said fork arms 24,25. Preferably each of the aforesaid second end portions 22,23 of the support bracket 10 comprises a respective through-opening 28,29 of circular cross-section. These through-openings 28,29 define a hinge axis and allow pivotally hinging the second motor 9 to the support bracket 10.

[0035] According to an embodiment, the support bracket 10 comprises a waveguide 30 integrated inside the bracket 10.

[0036] Preferably, the waveguide 30 is a channel defined in the thickness of the support bracket 10 and this bracket 10 is made of a metallic material, for example steel.

[0037] With reference to Figure 4, according to an advantageous embodiment, the support bracket 10 comprises two half-portions 27,28 made in two distinct pieces and juxtaposed and coupled to each other, for example by means of screws. In this way, the realisation of the waveguide 30 integrated in the support bracket 10 is particularly simple, since the waveguide 30 can be obtained by providing a first recess on a wall of one of the two half-portions 27,28 destined to be facing an opposite wall of the other of the two half-portions. Cleary, a second recess can also be provided on the aforesaid opposite wall that is facing and aligned with the first recess when the two half-portions 27,28 are coupled together.

[0038] In the case in which the support bracket 10 is fork-shaped with two fork arms 24,25, the aforesaid channel preferably has a portion that extends inside one of said fork arms 24,25. Preferably, the aforesaid channel extends between two openings of the channel from the first end portion 20,21 of the support bracket 10 to the second end portion 22,23 of the support bracket 10 so as to define a waveguide 30 that extends from the base 6 of the steerable antenna 3 to the payload 4,5. A waveguide connector can be provided on the base 6 disposed in correspondence of the respective opening of the channel.

[0039] With reference to Figure 3, according to an embodiment, the steerable antenna 3 comprises a first rotating waveguide joint 31 having a joint portion fixed to the support bracket 10, in correspondence of the second end portion 22,23 that is operatively coupled to the integrated waveguide 30 and is in operative communication with the latter and a second joint portion operatively coupled to the payload 4,5. Preferably, the second motor 9 is fixed to the second portion of rotating waveguide joint, in the example shown outside of this. With joint reference to Figures 3 and 5, in the particular example shown, the first rotating waveguide joint 31 is fixed to the arm 25 of the support bracket 10 and in particular engaged in the through-opening 29 passing and, in this way, allows pivotally hinging the second motor 9 to the arm 25 of the support bracket 10. Preferably, a hinge pin 32 is provided on the other side of the support bracket 10 that includes a portion with a smooth surface engaged in the second motor 9 and a threaded portion screwed into the through-opening 28 of the arm 24 of the support bracket 10.

[0040] The second motor 9 comprises a motor shaft 35. According to a preferred embodiment, the second motor comprises a container body 39 and preferably a stator 33 housed inside the container body 39 and a rotor 34. In this case, the motor shaft 35 is preferably fixed or coupled to the rotor 33. According to a preferred embodiment, the container body 39 is fixed to the first driven pulley 8 and is pivotally hinged to the support bracket 10 to be able to rotate about the first rotation axis. The motor shaft 35 of the second motor 9 is coupled to the payload 4,5 by means of a connection element 36, preferably a first coupling flange 36 or connection flange 36.

[0041] According to an embodiment, to the motor shaft 35 of the second motor 9 is coupled a speed and/or position transducer 45 integral with the motor shaft 35 in its rotation around the second rotation axis.

[0042] According to an embodiment, the payload 4,5 is coupled to the outer container 39 of the second motor 9 by means of a second coupling flange 37 and a second rotating joint 41, shown in Figure 5. Preferably the second rotating joint 41 and the coupling flange 37 are waveguide devices and allow realising a waveguide connection by means of a connection waveguide 38, operatively interconnected between the first waveguide joint 31 and the second waveguide 41 and integral in rotation with the second motor 9.

[0043] With reference to Figure 5, according to an embodiment, the first driven pulley 8 has a central arch-shaped portion 50 and two lateral arms 51,52 fixed to the container body 39 of the second motor 9. The rotation of the first driven pulley 8 thus determines a rotation of the container body 39 of the second motor 9 around the first rotation axis.

[0044] According to an embodiment, the first motor 7 comprises a container body 70, a stator 71 housed inside the container body 70, a rotor 72 and a motor shaft 73 fixed or coupled to the rotor 72. The container body 70 is fixed to the base 6. According to an embodiment, to the motor shaft 73 of the first motor 7 is coupled a speed and/or position transducer 74.

[0045] According to an embodiment, the motor shaft 73 of the first motor 7 is preferably coupled directly, i.e., without transmission reduction gear, to the first driven pulley 8.

[0046] According to a preferred embodiment, the electromechanical movement and support system 6-10 comprises a band transmission system 18,19,48,49, and more preferably a transmission system with metal bands 18,19,48,49, suitable to operatively couple the first motor 7 to the first driven pulley 8 comprising two bands 18,19 crossed with each other having a first end portion fixed to the first driven pulley 8, wherein said transmission system 18,19,48,49 comprises a first drive pulley 48,49 coupled to the first motor 7, and in particular to its motor shaft 73. The aforesaid bands 18,19 each have a second end portion fixed to the first drive pulley 8. Preferably, the second end portions of the bands 18,19 are fixed to opposite end portions 53,54 of the arch-shaped central portion 50 of the first driven pulley 8.

[0047] According to an embodiment, the aforesaid bands 18,19 are made of a metal alloy, for example a superalloy with an austenitic nickel-chrome structure. Preferably such bands have a reduced thickness, for example of the order of a tenth of a millimetre, for example equal to a tenth of a millimetre.

[0048] According to an embodiment, the first drive pulley 48,49 comprises two parallel pulleys 48,49, fixed to each other by means of a coupling system that allows adjusting the mutual orientation of said pulleys 48,49 in order to ensure a correct preloading of the bands 18,19.

[0049] Figures 7 to 10 partially show a transmission group 100,9 according to a presently preferred embodiment. The transmission group 100,9 is also shown in section in Figure 5. According to a preferred embodiment, the transmission group 100,9 comprises a transmission system 100 for oscillating systems (i.e., suitable to move a payload, in a periodic or non-periodic manner, between two distinct angular positions) coupled the second motor 9. In this regard, note that the applications of a transmission system 100 and a transmission group 100,9 according to this description are not limited to the sector of steerable antennas. In fact, a transmission system 100 according to this description can be applied to a variety of oscillating systems in which it is necessary to have a transmission ratio different from unity, and in particular a reduction ratio. In general, the teachings relating to the transmission system 100 and to the transmission group 100,9 according to this description can be applied to any oscillating system in which it is necessary to have a transmission ratio different from unity. According to a preferred embodiment, the transmission system 100 is a transmission reduction gear.

[0050] The transmission system 100 comprises a second drive pulley 110 actuatable in rotation about a rotation axis of rotation of the second drive pulley 110. According to an embodiment, the rotation axis of the second drive pulley 110 coincides with the rotation axis of the motor shaft 35 of the second motor 9. Preferably, the second drive pulley 110 is integral in rotation with the motor shaft 35 of the motor 9. In other words, the drive pulley 110 can be rigidly connected to the drive shaft 35 or can alternatively be formed in one piece with such motor shaft 35.

[0051] The transmission system 100 comprises a second driven pulley 120. Furthermore, the transmission system 100 comprises a first and a second flexible transmission element 130A,130B operatively coupled to the second drive pulley 110 and the second driven pulley 120 for the transmission of a motion between such pulleys 110,120. According to a preferred embodiment, the first and second transmission element 130A,130B respectively comprise a first and a second metal band 130A,130B, which are preferably made of harmonic steel. The fact of realising the first and the second flexible transmission element 130A,130B in the form of metal bands allows conveniently ensuring the rigidity of the transmission, low friction and total, or almost total, absence of slack. As an alternative to the metal bands 130A,130B, one can use a first and a second steel cable, which are also suitable to ensure an equivalent rigidity of the transmission, low friction and total, or almost total, absence of slack. In the case where the transmission system 100 is used for applications that have less stringent requirements for the rigidity of the transmission, low friction and absence of slack, with respect, for example, to applications in the steerable antennas of a missile seeker, as an alternative to the metal bands, one can use other flexible transmission elements such as, for example and not limited to, belts, chains, ropes, non-metallic cables and, in general, further flexible transmission elements that can present a higher elasticity than metal bands.

[0052] The first transmission element 130A comprises a first and a second connection portion 131A,132A. The second transmission element 130B comprises a first and a second connection portion 131B,132B. Preferably, the first and second connection portions 131A,132A and 131B,132B are end portions of the transmission elements 130A,130B. Each of the first connection portions 131A,131B is preferably removably fixed to the drive pulley 110. Preferably each of the first connection portions 131A,131B comprises a first connection pin 131A,131B that is fixed directly to the drive pulley 110 through axial insertion in a respective cavity provided in the drive pulley 110 and partially counter-shaped with respect to the connection pin 131A,131B so as to prevent the uncoupling of the pin 131A,131B in the radial direction.

[0053] The transmission system 100 comprises a fixed part 150 with respect to the second drive pulley 110 and the second driven pulley 120. The second connection portions 132A,132B are preferably removably fixed to the fixed part 150. According to a preferred embodiment, the second connection portion 132B comprises a second connection pin 132B that is fixed directly to the fixed part 150 through axial insertion in a respective cavity provided in the fixed part 150 and partially counter-shaped with respect to the second coupling pin 131B so as to prevent an uncoupling of the pin 132B in the radial direction. According to a preferred embodiment, the transmission system 100 comprises a tensioning device 160 fixable to the fixed part 150 and suitable to preload the first and second flexible transmission element 130A,130B. Preferably, the second connection portion 132A is fixed indirectly to the fixed part 150 by means of the tensioning device 160. With reference to Figure 8, the second connection portion 132A preferably comprises a second connection pin 132A that is preferably fixed to the fixed part 150 through axial insertion in a respective cavity provided in the tensioning device 160 and partially counter-shaped with respect to the second connection pin 132A. In particular, the second connection pin 132A is interposed between the tensioning device 160 and the fixed part 150 so as to be fixed to the fixed part 150. According to a preferred embodiment, the tensioning device 160 is preferably coupled to an axially projecting portion of the fixed part 150. Preferably, the tensioning device 160 is coupled to the fixed part 150 so as to slide with respect to the fixed part 150. For this purpose, the device 160 comprises, for example at least one rib which is suitable to engage a corresponding at least one groove 155 (Figure 11) provided in the fixed part 150. Preferably, the tensioning device 160 comprises a pair of ribs suitable to engage in a pair of grooves 155. Preferably, the tensioning device 160 comprises fixing elements 162 suitable to block the device 160 with respect to the fixed part 150. For example the fixing elements 162 can comprise a pair of fixing screws 162 each suitable to pass through a respective adjustment slot 163 (a single slot 163 can be seen in Figure 7) provided in the tensioning device and to each couple to a respective fixing hole 156 (Figure 11) provided in the fixed part 150.

[0054] According to an alternative embodiment, in the case in which one requires less precision of the transmission position, the tensioning device 160 may not be provided and the second connection portion 132A may be fixed directly to the fixed part 150. In particular, the second connection portion 132A can comprise the aforesaid second connection pin 132A, which, analogously to the second connection pin 132B, can be axially inserted in a respective cavity provided in the fixed part 150 and partially counter-shaped with respect to the second coupling pin 132A so as to prevent a radial uncoupling of the second connection pin 132A.

[0055] Always with reference to Figures 7 to 10, the transmission system 100 comprises the aforesaid connection element 36 or connection flange 36, for connecting the transmission system 100 to the payload 4,5. The connection element 36 is arranged to rotate around the rotation axis of the drive pulley 110. More particularly, the connection element 36 is bound so as to be able to exclusively rotate around the rotation axis of the second drive pulley 110. The connection element 36 is integral in rotation with the second driven pulley 120 around the rotation axis of the drive pulley 110. The drive pulley 110 is suitable to drag the second driven pulley 120 and the connection element 36 in rotation in a first rotation direction (indicated by the arrow A1 in Figure 9) and in a second rotation direction opposite to each other respectively by means of the first and second flexible transmission element 130A,130B. In particular, the second driven pulley 110 is suitable to drag the second driven pulley 120 and the connection element 36 in rotation around the rotation axis of the drive pulley 110.

[0056] Note that during the rotation of the second driven pulley 120 and of the connection element 36 in one of the aforesaid first (arrow A1) and second direction, the pull is ensured only by one of said first and second transmission element 130A,130B, and more particularly by the transmission element 130A, 130B that works in traction. For example, during the rotation of the driven pulley 120 around the rotation axis of the drive pulley 110 in the direction of the arrow A1 of Figure 9, the pull is ensured only by the first flexible transmission element 130A.

[0057] According to an embodiment, the second driven pulley 120 and the connection element 36 are suitable to rotate between a first and a second angular position distinct from each other and angularly spaced around the rotation axis of the drive pulley 110. In Figure 9, the driven pulley 120 and the connection element 36 are shown in the first angular position. In figures 7 to 8, the driven pulley 120 and the connection element 36 are shown in a central angular position that is intermediate between said aforesaid first and second angular position (this second angular position is not shown in the figures). Even in the schematic representation of Figure 12, the driven pulley 120 is illustrated in said central angular position, which is intermediate between the first and second angular position. According to a preferred embodiment, the first and the second angular position that can be assumed by the pulley 120 and the connection element 36 are angularly spaced from each other by an angle less than 180° and more preferably by an angle less than about 120°. In the example, these first and second angular positions are angularly spaced from each other by an angle of about 105°.

[0058] According to a preferred embodiment, the connection element 36 is rotatably fitted to the fixed part 150 to rotate around the rotation axis of the drive pulley 110.

[0059] With cross-reference to Figures 7 to 10 and to Figure 11, according to a preferred embodiment, the fixed part 150 comprises a fixed bushing 150 that is coaxial with and extended around the drive pulley 110. The fixed bushing 150 comprises a bushing through-opening 151 interposed between the drive pulley 110 and the driven pulley 120 to allow the passage of the first and second flexible transmission element 130A,130B between the drive pulley 110 and the driven pulley 120. According to a preferred embodiment, the fixed bushing 150 comprises a fixing flange 157, preferably an annular fixing flange 157, for fixing the fixed bushing to the container body 39 of the second motor 9.

[0060] With reference to Figure 11 and the schematic representation of Figure 12, according to a preferred embodiment, the fixed bushing 150 comprises a radially inner face 152A and an opposite radially outer face 152B. Preferably, the first and second flexible transmission element 130A,130B each comprise consecutively a first section 133A,133B wound onto the drive pulley 110 and interposed between the drive pulley and the radially inner face 152A of the bushing 150, a second section 134A,134B extending in a space between the drive pulley 110 and the driven pulley 120, a third section 135A,135B wound onto the driven pulley 120 and a fourth section 136A,136B partially wound onto the radially outer face 152B of the bushing 150. As can be seen for example in Figure 12, the second section 134A of the first transmission element 130A and the second section 134B of the second transmission element 130B intersect in the said space present between the drive pulley 110 and the driven pulley 120.

[0061] According to an embodiment, the transmission system 100 comprises a connection member 140 including said connection element 36. The connection member 140 comprises an annular coupling portion 142 for coupling the connection member 140 to the fixed bushing 150. The annular coupling portion 142 is coaxial to the drive pulley 110 and defines a coupling opening 144 crossed by the fixed bushing 150.

[0062] With reference to Figure 10, according to an embodiment, the transmission system 100 comprises a coupling shaft 170 connected to the driven pulley 120 and the connection member 140 for coupling the driven pulley 120 to the connection member 140. Preferably, the driven pulley 120 is coupled to the coupling shaft 170 so as to be able to rotate around a rotation axis of the driven pulley 120 that is parallel to the rotation axis of the drive pulley 110. According to an embodiment, the driven pulley 120 and the connection member 140 are coupled to the connection shaft 170 and to the fixed bushing 150 respectively by at least a first and at least a second clearance recovery coupling bearing 121,143. For example, the at least one first bearing coupling 121 comprises a first pair of opposing oblique contact bearings 121 and the at least one second coupling bearing 143 comprises, in the same way, a second pair of opposing oblique contact bearings 143.

[0063] With reference to Figure 11, according to a preferred embodiment, the fixed bushing 150 comprises a first and a second axially-extended edge 153A,153B that delimit the opening 151. Preferably, the fixed bushing 150 comprises a first and a second support portion 154A,154B that protrude respectively from the first 153A and from the second 153B edge and that are circumferentially offset between them. The first and the second transmission element 130A,130B are suitable to rest respectively to the first and second support portion 154A,154B when the driven pulley 120 assumes respectively the aforesaid first and second angular position.

[0064] Having described the structure of the transmission system 100, we now describe an exemplifying and nonlimiting mode of functioning of such systems with reference to the embodiment illustrated in the accompanying figures.

[0065] Assume that, starting from the configuration of Figures 8 or 12, the motor shaft 35 of the second motor 9 drags the drive pulley 110 in rotation in the rotation direction opposite the rotation direction indicated by the arrow A1 in Figure 9. This rotation causes the dragging of the first band 130A, which begins to wind itself on the drive pulley 110. This rotational movement induces a reduction of the free length of the first band 130A (which is to say of the second section 134A of the band 130A), which band 130A has the respective second connection portion 132A fixed to the fixed bushing 150. Consequently, the driven pulley 120 and the connection flange 36 are induced to rotate around the axis of the drive pulley 110 in the direction indicated by arrow A1 in Figure 9. Note that, on the driven pulley 120, there is no slipping because this pulley 120 can rotate on itself around the respective rotation axis.

[0066] The transmission ratio of the transmission system 100 depends on the size of the drive and driven pulleys 110,120 and the distance of the respective rotation axes or their respective centres. Specifically, with reference to Figure 12, indicating with *Rc* the radius of the trajectory of the centre or rotation axis of the driven pulley 120, (this trajectory and the radius *Rc* are represented by dashed lines in Figure 12), with *Rm* the radius of the drive pulley 110 (the radius *Rm* is represented by a dashed line in Figure 12), with T a pull on the first band 130A (Figure 12 shows the pull in the case of a counterclockwise rotation of the drive pulley 110) and with *Tc* the effective component (i.e., the component tangential to the trajectory of the centre or rotation axis of the driven pulley 120) of resultant of the pulls T acting on the driven pulley 120, the transmission ratio p of the transmission system 100 is obtainable as follows:

$$\rho = \frac{Tc * Rc}{T * Rm}$$

[0067] Based on the above, it is therefore possible to understand how a transmission system of the type described above allows achieving the purposes mentioned above with reference to the state of the prior art.

[0068] In a transmission 100 system according to this description, the connection flange 36 is suitable to rotate about the rotation axis of the drive pulley 110 rather than around the rotation axis of the driven pulley 120, which conveniently allows obtaining a relatively compact and space-saving transmission system compared to the pulley and band transmission system of the prior art discussed above.

[0069] According to an aspect of the invention, note also that the steerable antenna described above has a particularly compact structure and has a high transversal rigidity. In fact, the whole system develops around a rigid central body consisting of the support bracket 10 and the base 6. In addition, the embodiment that provides for a waveguide integrated in the support bracket 10 is particularly advantageous as it is possible to avoid the provision of a radio frequency cable that is moved during manoeuvres of the steerable antenna.

[0070] Without prejudice to the principle of the invention, the forms of implementation and construction details may be varied widely with respect to what has been described and illustrated purely by way of nonlimiting example, without thereby departing from the invention as defined in the appended claims.

Claims

1. Transmission system (100) for oscillating systems comprising:

   - a drive pulley (110) operable in rotation about an axis of rotation of the drive pulley;
   - a driven pulley (120);
   - a first and a second flexible transmission element (130A, 130B) operatively coupled to the drive pulley (110) and the driven pulley (120) for the transmission of a movement between said pulleys (110, 120), the first and second flexible transmission elements (130A, 130B) each comprising a first and a second connection portion (131A, 131B, 132A, 132B), each of said first connection portions (131A, 131B) being attached to the drive pulley (110); and
   - a connection element (36) to connect the transmission system (100) to a payload (4, 5) the connection element (36) being integral in rotation with the driven pulley (120) around an axis of rotation;

   the drive pulley (110) being adapted to drag the driven pulley (120) and the connection element (36) in rotation in a first and in a second direction of rotation opposite to each other respectively by means of the first and second flexible transmission elements (130A, 130B);
   said transmission system (100) being **characterised in that**:

   - the connection element (36) is arranged to rotate around the axis of rotation of the drive pulley (110);
   - comprises a fixed part (150) with respect to said drive and driven pulleys (110, 120), said second connection portions (132A, 132B) being attached to said fixed part (150);
   - said rotation axis around which the driven pulley (120) and the connection element (36) are integral in rotation is the axis of rotation of the drive pulley (110).

2. Transmission system (100) according to claim 1, wherein the connection element (36) is rotatably fitted to the fixed part (150) to rotate around the axis of rotation of the drive pulley (110).

3. Transmission system (100) according to any of the previous claims, wherein such fixed part (150) comprises a fixed bushing (150) coaxial and extending around the drive pulley (110), the fixed bushing (150) comprising a bushing through-opening (151) interposed between the drive pulley (110) and the driven pulley (120) to allow the passage of the first and second flexible transmission element(130A , 130B) between the drive pulley (110) and the driven pulley (120).

4. Transmission system (100) according to claim 3, where the fixed bushing (150) comprises a radially inner face (152A) and an opposite radially outer face (152B), and wherein the first and second flexible transmission elements (130A, 130B) each comprise consecutively a first section (133A, 133B) wound onto the drive pulley (110) and interposed between the drive pulley and the radially inner face (152A) of said bushing (150), a second section (134A, 134B) extending in a space between the drive pulley (110) and the driven pulley (120), a third section (135A, 135B) wound onto the driven pulley (120) and a fourth section (136A, 136B) partially wound onto the radially outer face (152B) of said bushing (150), said second sections (134A, 134B) crossing over in said space between the drive pulley (110) and the driven pulley (120).

5. Transmission system (100) according to claim 3 or 4, comprising a connection member (140) including said connection element (36), the connection member (140) comprising an annular coupling portion (142) to couple the connection member (140) to the fixed bushing (150), said annular coupling portion (142) being coaxial to the drive pulley (110) and defining a coupling opening crossed by the fixed bushing (150).

6. Transmission system (100) according to any of the claims from 3 to 5, comprising a tensioning device (160) attachable to the fixed bushing (150) and suitable to preload said first and second flexible transmission element (130A, 130B), the second connection portion (132A) of the first flexible transmission element(130A) being attached to the fixed bushing

(150) by means of said tensioning device (160).

7. Transmission system (100) according to claim 5, comprising a coupling shaft (170) connected to the driven pulley (120) and to the connection member (140) to couple the driven pulley (120) to the connection member (140), in which the driven pulley (120) and the connection member (140) are coupled to the coupling shaft (170) and to the fixed bushing (150) respectively by at least a first and at least a second clearance recovery coupling bearing(121,143).

8. Transmission system (100) according to any of the previous claims, in which the first and second transmission element (130A, 130B) respectively comprise a first and a second metal band (130A, 130B) or a first and a second steel cable.

9. Transmission system (100) according to any of the preceding claims wherein said transmission system is a reduction gear.

10. Transmission group (100, 9) comprising a motor (9) including a drive shaft (35) and a transmission system (100) according to any of the previous claims coupled to said motor (9), said drive pulley (110) being integral in rotation with said drive shaft (35).

11. Steerable antenna (3) comprising a transmission group as defined in claim 10.

12. Steerable antenna (3) according to claim 11, wherein said motor (9) is a second motor (9), said antenna comprising:

- said payload (4,5);
- an electromechanical movement and support system (6-10) operatively connected to the payload (4, 5) and adapted to orient the payload in a controlled manner, said electromechanical system comprising a base (6), a first motor (7) attached to the base (6), a first driven pulley (8) operatively connected to the first motor (7) for being rotated around a first rotation axis, said second motor (9) operatively connected to the first driven pulley (8) and operatively connected to the payload (4,5) for rotating the payload around a second rotation axis;

the electromechanical movement and support system (6-10) further comprises a support bracket (10) stably fixed to the base (6) to which the second motor (9) is pivotally hinged and the first driven pulley (8) is operatively connected to the second motor (9) for rotating the second motor (9) in relation to the base (6) and in relation to the support bracket (10).

13. Steerable antenna (1) according to claim 12, wherein said support bracket (10) comprises a first end portion (20,21) attached to the base (6) and a second end portion (22,23) to which the second motor (9) is pivotally hinged.

14. Steerable antenna (1) according to claim 13, wherein said support bracket (10) is fork-shaped, and wherein said second end portion (22,23) comprises two end portions between which said second motor (9) is pivotally hinged.

15. Seeker comprising a steerable antenna (1) according to any of the claims from 11 to 14.

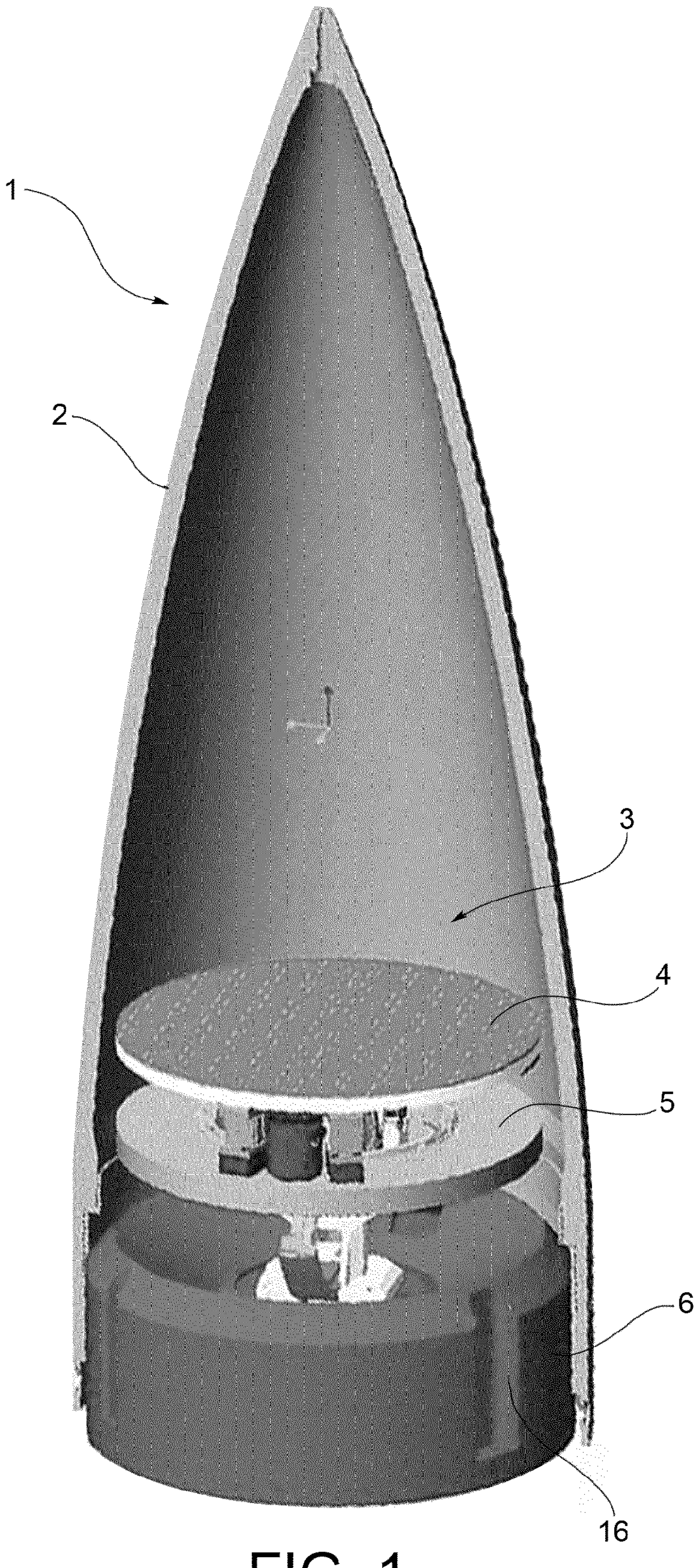
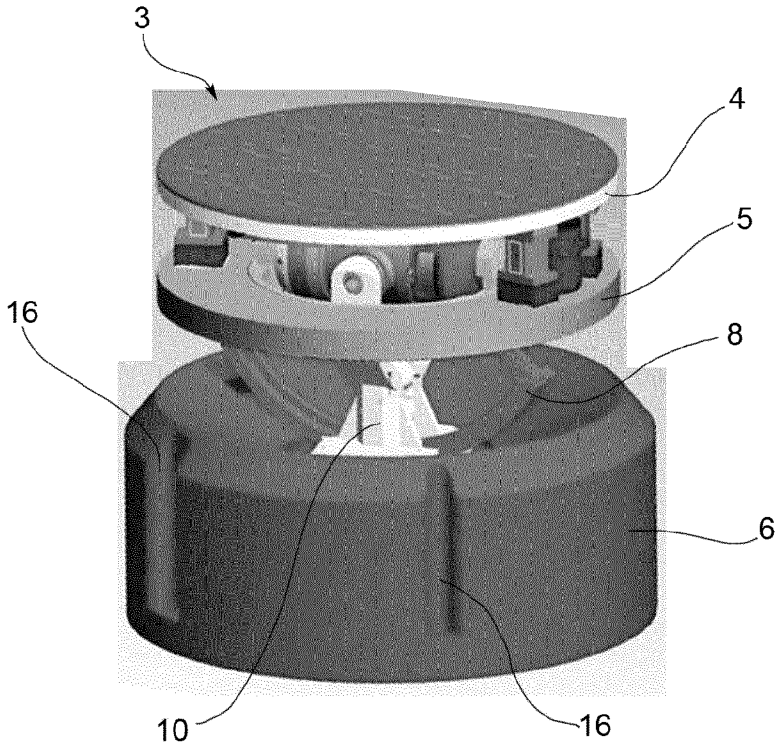


FIG. 1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6
10
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FIG. 2

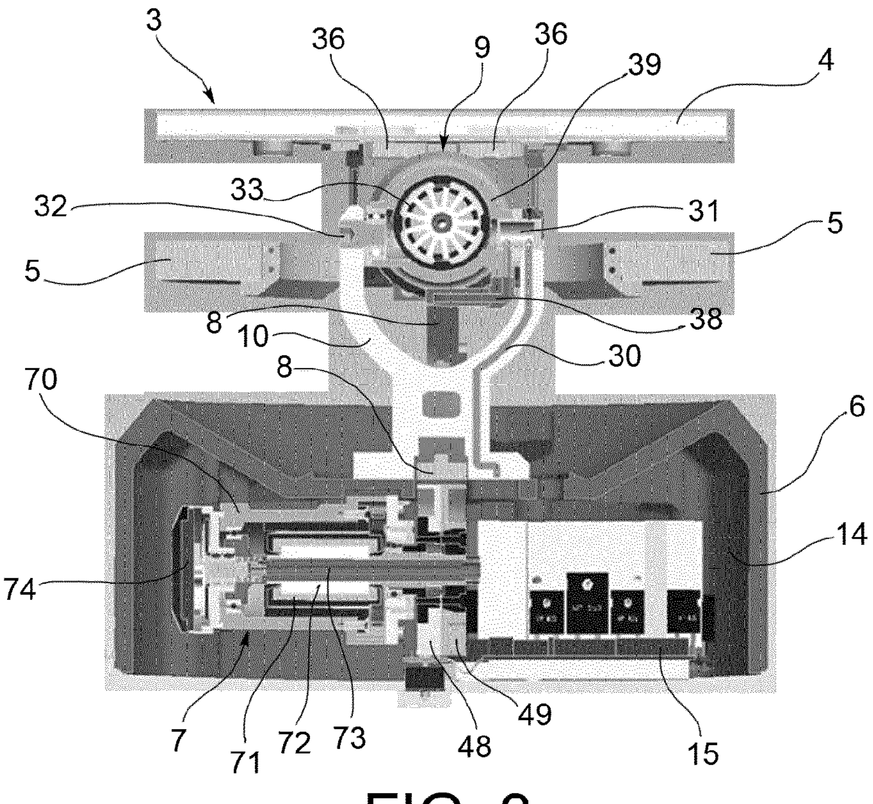
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FIG. 3

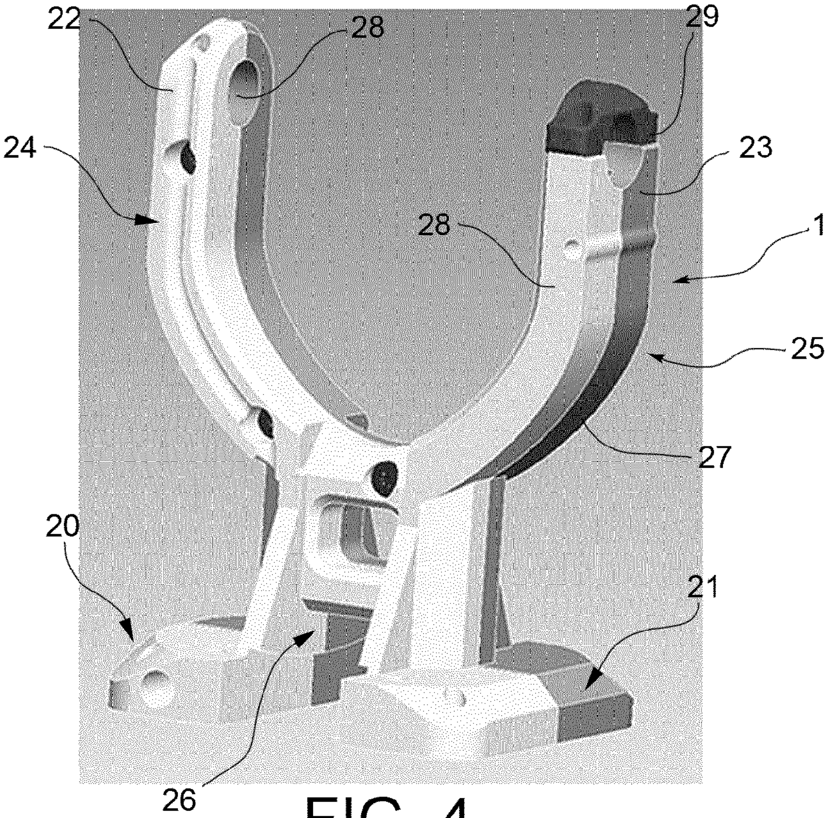
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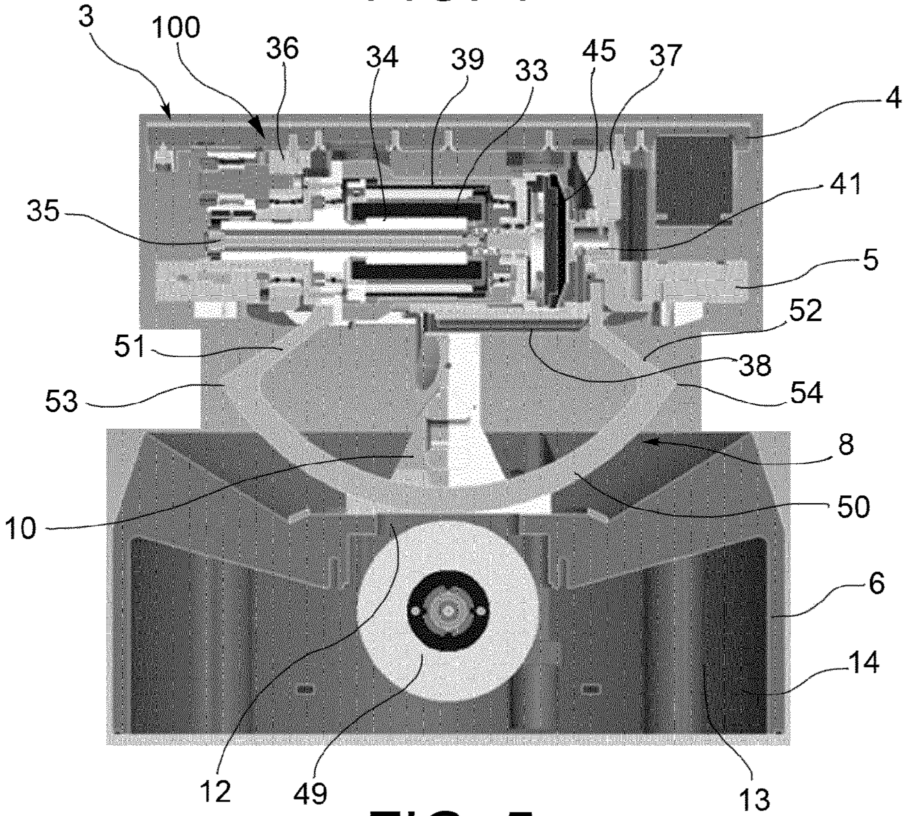
FIG. 4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34
39
33
45
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4
41
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5
52
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38
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54
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6
14
12
49
13

FIG. 5

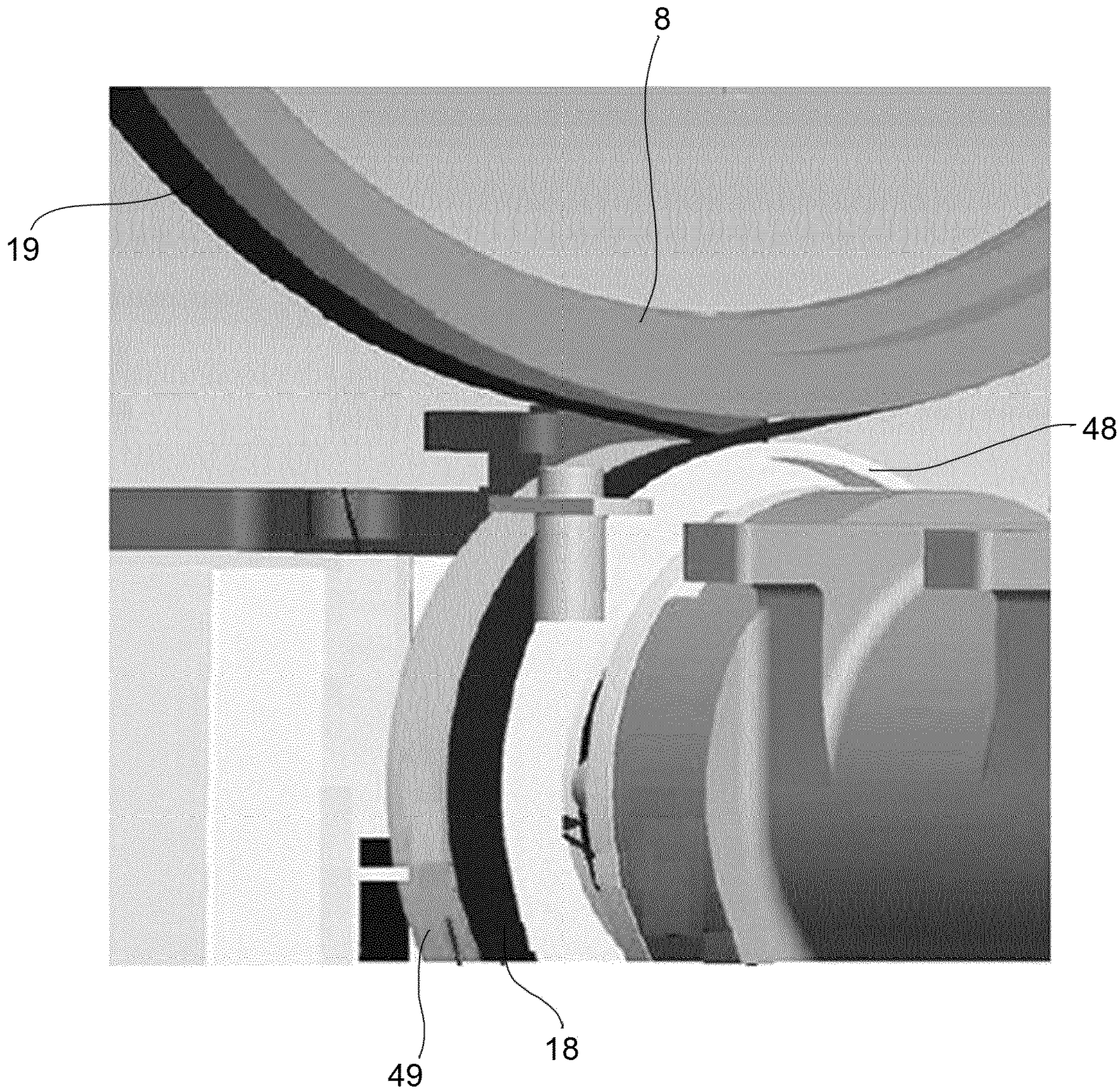
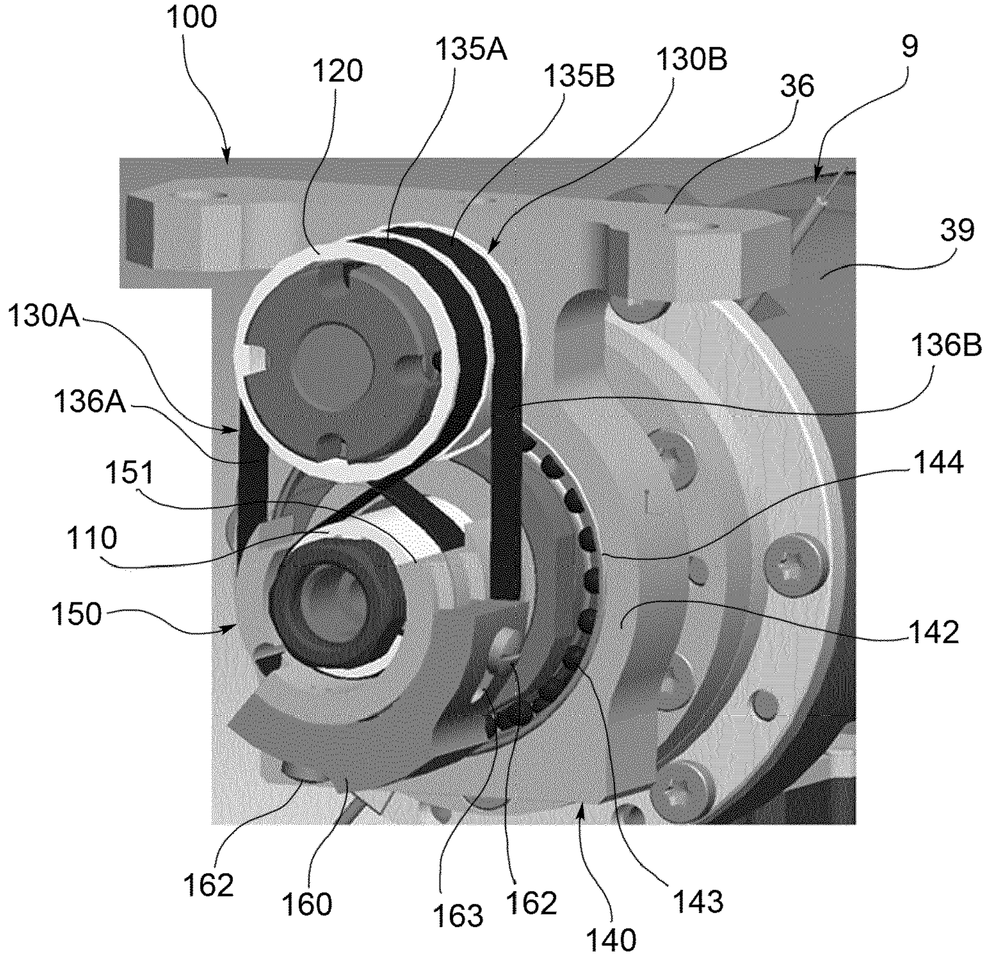


FIG. 6


100
120
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135B
130B
36
9
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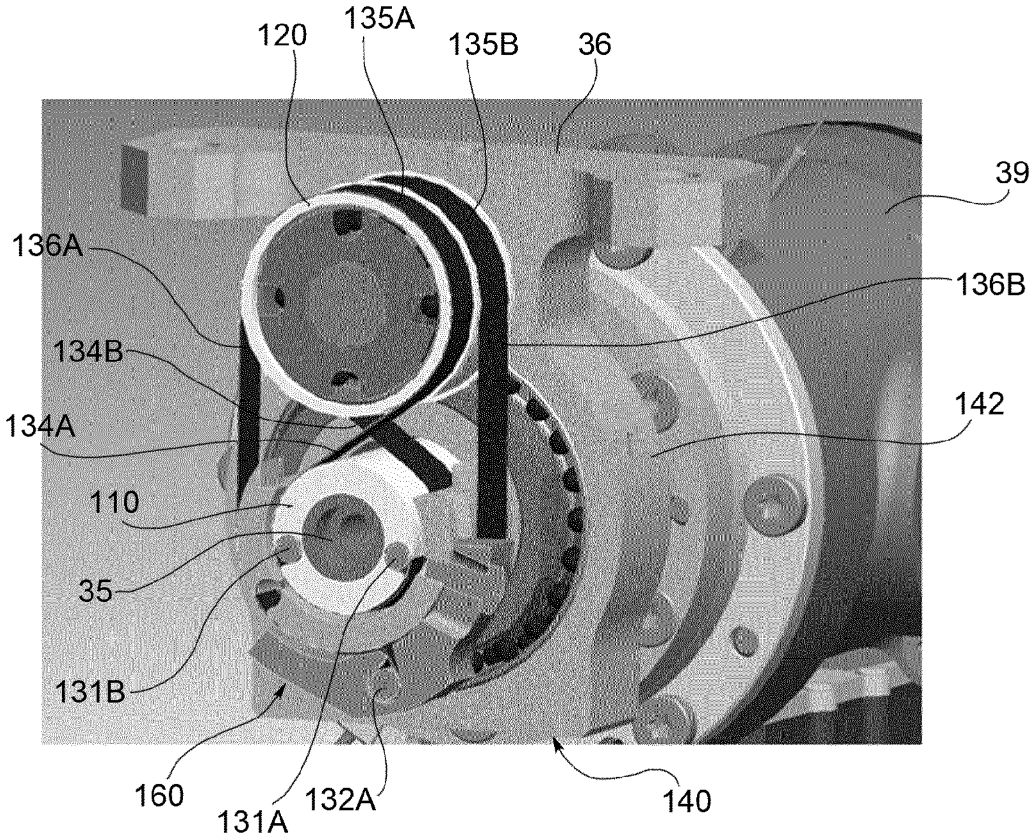
162
140
143

FIG. 7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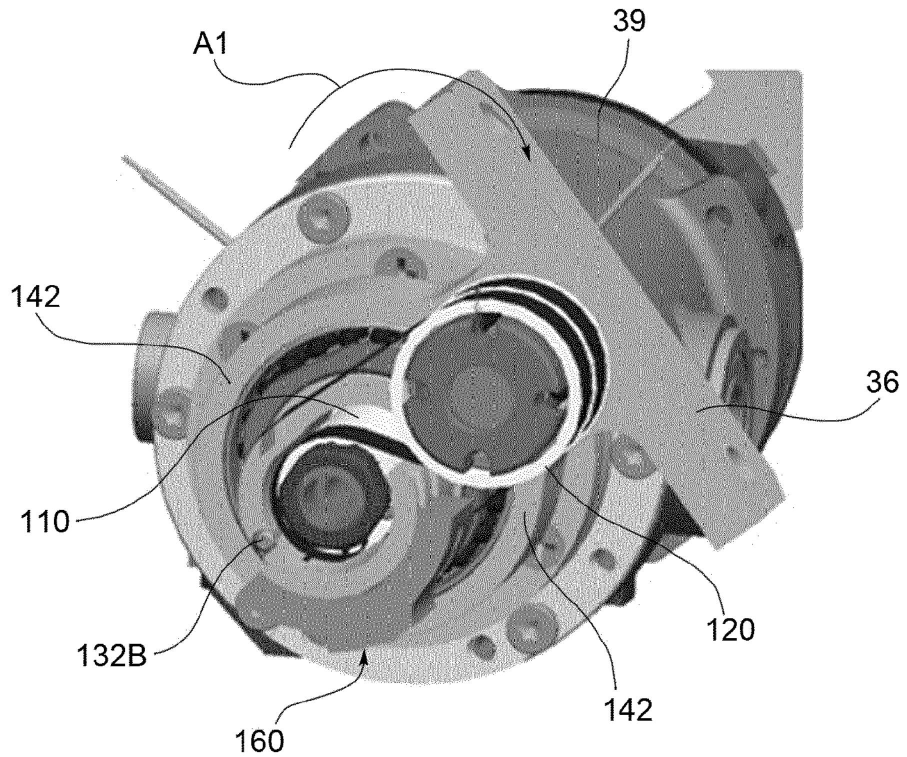
131A
132A
140

FIG. 8


A1
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132B
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160

FIG. 9

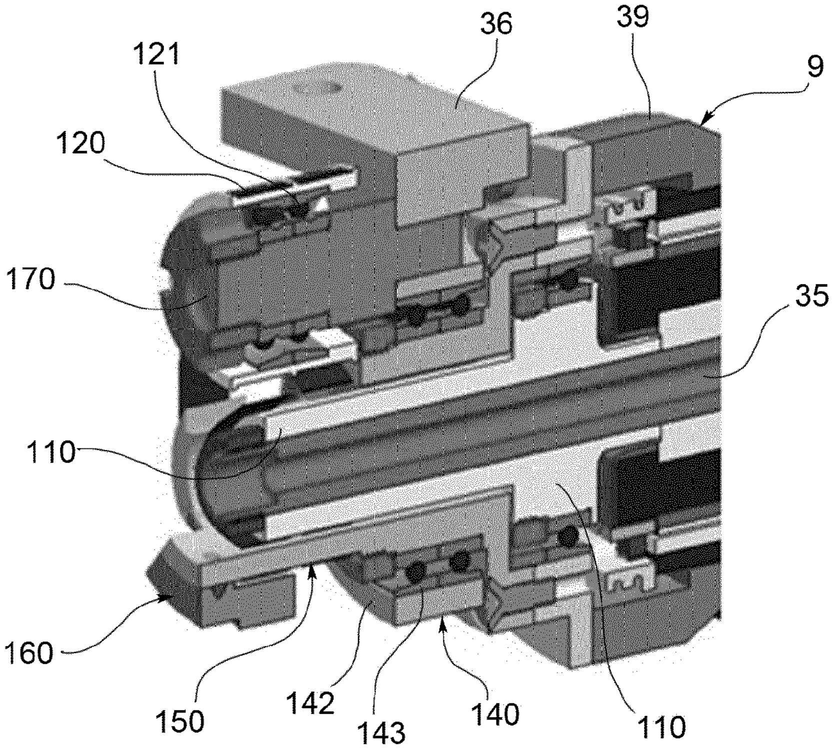
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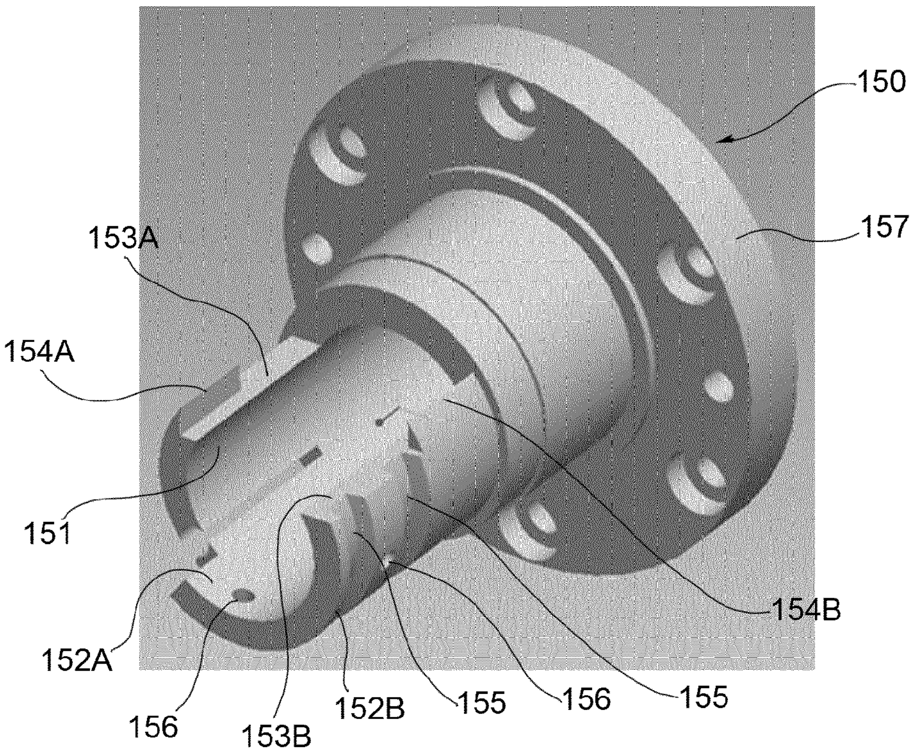
FIG. 10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154A
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154B
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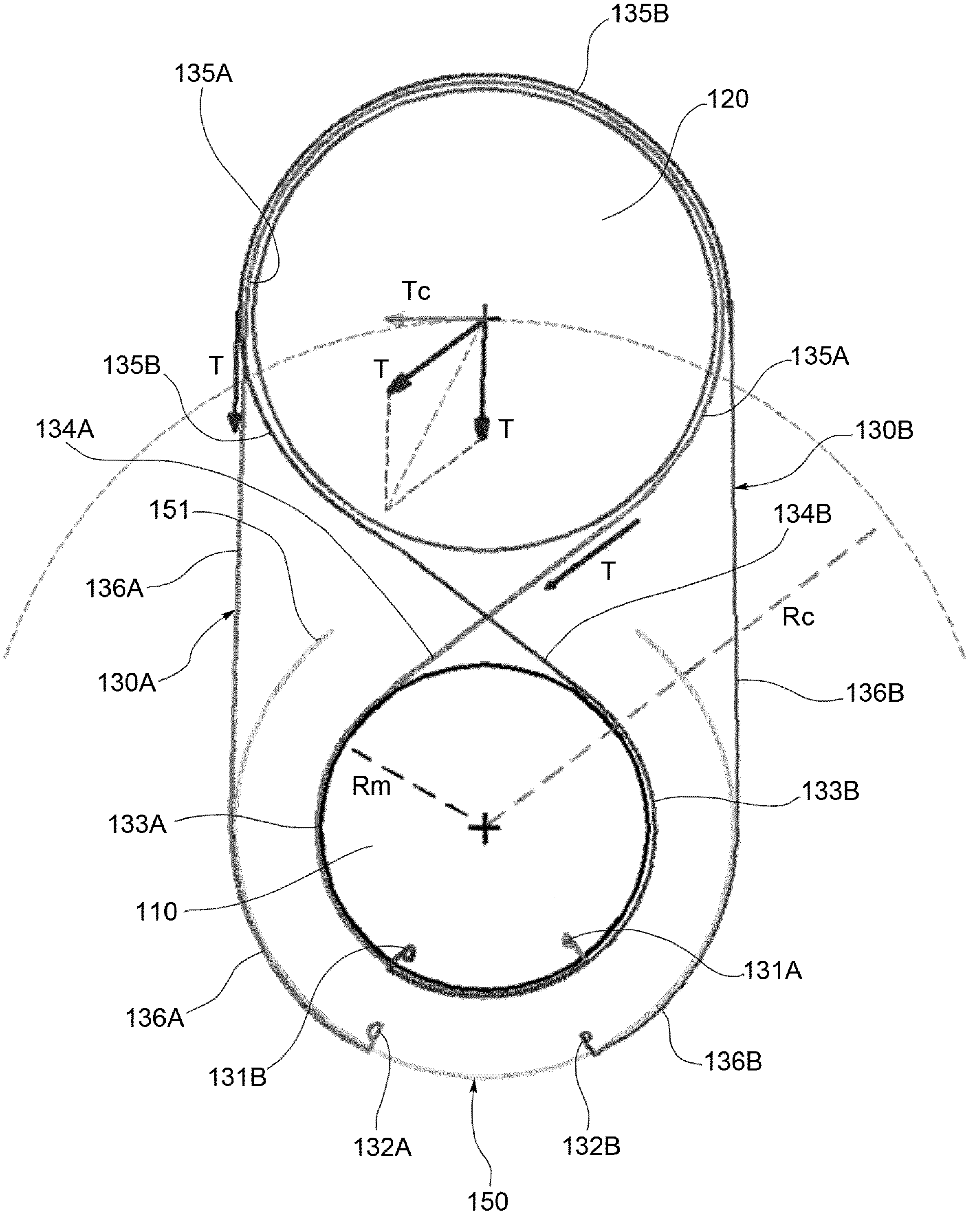
153B
152B
155
156
155

FIG. 11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T
136A
Rc
130A
136B
Rm
133B
133A
110
131A
136A
136B
131B
132A
132B
150

FIG. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 16 17 4930

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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F16H
H01Q
G01S
F16M

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	3 November 2016	Vial, Antoine

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