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(54) DEPILATING DEVICE

(57) A depilating device (5) comprises a depilating body (10) which is rotatable about a rotation axis (R) extending in a longitudinal direction (L) with respect to the depilating body (10), an actuating mechanism (30) configured to act on the depilating body (10) so as to cause compression and extension of the depilating body (10) in the longitudinal direction (L) during rotational movement of the depilating body (10) about the rotation axis (R), and a driving mechanism (20) configured to drive the depilating body (10) and to also drive the actuating mechanism (30). The actuating mechanism (30) is connected to a drive shaft (21) of the driving mechanism (20) in a resilient fashion, such as through at least one leaf spring (51), which contributes to minimizing friction and noise in the depilating device (5), and which may also support one of compression and extension of the depilating body (10).

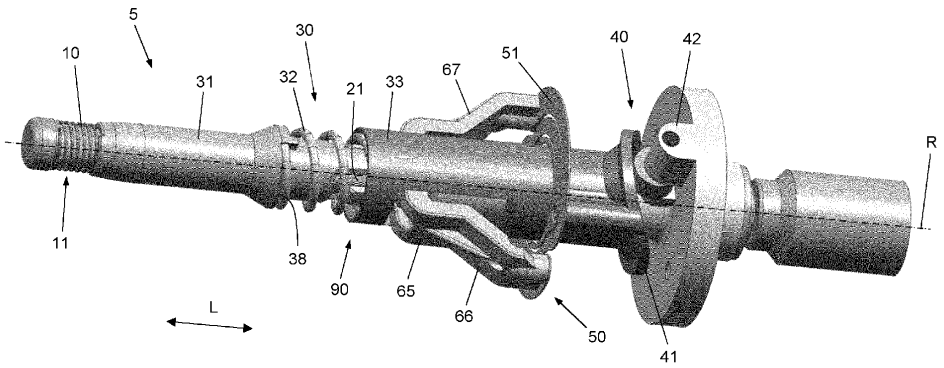

Fig. 33

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a depilating device comprising a depilating body which is rotatable about a rotation axis extending in a longitudinal direction with respect to the depilating body and which is provided with at least one hair-catching space, wherein the size of the at least one hair-catching space in the longitudinal direction is variable through compression and extension of the depilating body in the longitudinal direction, an actuating mechanism configured to act on the depilating body so as to cause compression and extension of the depilating body in the longitudinal direction during rotational movement of the depilating body about the rotation axis, and a driving mechanism configured to drive the depilating body so as to perform the rotational movement about the rotation axis, wherein the driving mechanism comprises a rotatable drive shaft coupled to the depilating body for imposing rotational movement on the depilating body, and wherein the driving mechanism is configured to also drive the actuating mechanism so as to cause compression and extension of the depilating body in the longitudinal direction.

BACKGROUND OF THE INVENTION

[0002] A depilating device as described here before is known from WO 2021/130385 A1. In the known depilating device, the actuating mechanism includes a force-inducing member which is compressible and extendable in the longitudinal direction and which is configured to determine the level of a force exerted by the actuating mechanism on the depilating body in the longitudinal direction when the size of the force-inducing member in the longitudinal direction is varied while the at least one hair-catching space of the depilating body is in a closed condition. A practical example of the force-inducing member is a spring. As a result of the presence of the force-inducing member in the actuating mechanism, the hair-clamping force is no longer determined by a force-displacement characteristic of compression and extension of the depilating body only, but also by a force-displacement characteristic of compression and extension of the force-inducing member. This means that a configuration is obtained in which the design of the depilating body can be adapted so as to have optimal hair-catching functionality of the depilating body and in which the design of the force-inducing member can be adapted so as to have optimal hair-clamping functionality of the depilating body as well. At the same time, it is possible to have a construction of the depilating device that is producable within acceptable and realistic production tolerances, while the force by the force-inducing member stays within an acceptable bandwidth to be able to clamp the hairs and pull them out of the skin, and to not cut the hairs by too much force.

[0003] In an embodiment, the actuating mechanism of the depilating device known from WO 2021/130385 A1 comprises two actuating members which are both movable in the longitudinal direction, wherein a first one of the actuating members is at a position closer to the depilating body in the longitudinal direction than a second one of the actuating members, and wherein the force-inducing member is at a position of coupling the actuating members to each other. Further, each of the actuating members is bush-shaped and at a position for surrounding a portion of the drive shaft. For the purpose of enabling transfer of torque from the drive shaft to each of the actuating members while also allowing movement of the actuating members in the longitudinal direction, each of the actuating members comprises a groove extending in the longitudinal direction, and the drive shaft is provided with respective projecting pins accommodated in the respective grooves.

[0004] Although the depilating device known from WO 2021/130385 A1 functions well to perform the intended depilating function, there is room for improvements to the design of the depilating device. The use of groove-pin combinations as described here before involves generation of friction forces and noise, and the groove-pin combinations are susceptible to wear. It is an object of the invention to provide a new type of depilating device in which the disadvantages of the use of groove-pin combinations are avoided or at least decreased.

SUMMARY OF THE INVENTION

[0005] The invention provides a depilating device which comprises the following:

- a depilating body which is rotatable about a rotation axis extending in a longitudinal direction with respect to the depilating body and which is provided with at least one hair-catching space, wherein the size of the at least one hair-catching space in the longitudinal direction is variable through compression and extension of the depilating body in the longitudinal direction,
- an actuating mechanism configured to act on the depilating body so as to cause compression and extension of the depilating body in the longitudinal direction during rotational movement of the depilating body about the rotation axis,
- a driving mechanism configured to drive the depilating body so as to perform the rotational movement about the rotation axis, wherein the driving mechanism comprises a rotatable drive shaft coupled to the depilating body for imposing rotational movement on the depilating body, and wherein the driving mechanism is configured to also drive the actuating mechanism so as to cause compression and extension of the depilating body in the longitudinal direction, and
- a connecting arrangement configured to connect the

actuating mechanism to the drive shaft in a resilient fashion.

[0006] According to the invention, torque transfer from the drive shaft to the actuating mechanism while also allowing relative longitudinal movement as necessary for causing the compression and extension of the depilating body in the longitudinal direction takes place through a connection between the drive shaft and the actuating mechanism which has resilient properties. As compared to the known groove-pin connection, the resilient connection involves hardly any friction and can even be referred to as frictionless, is of a less noisy character and hardly susceptible to wear, because there is no need for components in a sliding configuration, while the resilient connection can be designed such that the torque transfer as necessary and the freedom of movement in the longitudinal direction are maintained. In practical embodiments, it may be so that the connecting arrangement comprises at least one resilient member. For example, it is practical if the connecting arrangement comprises at least one bellows or at least one leaf spring.

[0007] It may especially be advantageous if the connecting arrangement comprises a spring arrangement including two leaf springs which are coupled together in a rectangular shape, as this may increase robustness of the resilient connection so that excessive bending and tilting effects in the resilient connection can be avoided without a need for taking other movement delimiting measures such as using stops.

[0008] In a basic design of the resilient connection, at least one leaf spring is applied which is directly fixed to both the actuating mechanism and the drive shaft, in which case torque transmittal can be realized with minimal losses.

[0009] In the context of the invention, when the connecting arrangement comprises at least one leaf spring, many designs of the at least one leaf spring are feasible. According to a practical possibility, the at least one leaf spring is arranged so as to encompass a portion of the drive shaft or a portion of a component of the actuating mechanism. In that case, it is especially beneficial if the at least one leaf spring is shaped like a disc having a circular outer periphery, wherein further the at least one leaf spring may be provided with a central hole for allowing the drive shaft or the component of the actuating mechanism to pass through and slots so as to have the resilience/flexibility as appropriate in view of the torque transmittal to be realized and possible other requirements following from intended operation of the depilating device.

[0010] In the practical case that the connecting arrangement comprises at least one resilient member, the possibility of the connecting arrangement further comprising at least one non-resilient connecting member exists, although it may be practical to use at least one leaf spring which is directly fixed to both the actuating mechanism and the drive shaft, as explained here before. In the case that at least one leaf spring is used and the at least one leaf spring is shaped like a disc having a circular outer periphery, it may be practical if a type of non-resilient connecting member is used which comprises at least two legs, wherein ends of the respective legs are connected to a leaf spring at the position of an outer peripheral area of the leaf spring.

[0011] The arrangement of the depilating body in the depilating device may be such that one end of the depilating body is a fixed end having a fixed position in the longitudinal direction, and preferably also in a direction about the rotation axis, and the other end of the depilating body is a movable end having a variable position in the longitudinal direction, wherein the actuating mechanism is configured to act on the depilating body at the side of the movable end thereof. When the at least one hair-catching space of the depilating body is closed and the actuating mechanism acts to subject the depilating body to forces in a direction associated with compressing the depilating body, the depilating body is fixed in place and the hair-clamping force is effectively built up. Further, having a fixed part of the depilating body facilitates positioning the depilating body relative to skin to be subjected to a depilating action.

[0012] In the context of the invention, it is possible to realize a link between the function of causing compression and extension of the depilating body in the longitudinal direction and the function of rotating the depilating body in a mechanical way. For example, it may be beneficial if the depilating device comprises a movement-imposing arrangement including a cam and cam follower, wherein one of the cam and cam follower has a fixed position in the depilating device, and wherein the other one of the cam and cam follower is integrated in or fixed to one of the actuating mechanism and the connecting arrangement. In such a configuration, movement of at least one component of the actuating mechanism in the longitudinal direction is automatically induced as the drive shaft rotates, in a predetermined way following from the design of the cam and cam follower. The design of the moving-imposing arrangement may be chosen such as to realize a speed of closing the at least one hair-catching space of the depilating body which is high enough for achieving good hair-catching results and consequently achieving good depilation results, and which is low enough to not incur high (peak) forces in the depilating device.

[0013] The above-mentioned link between the function of causing compression and extension of the depilating body in the longitudinal direction and the function of rotating the depilating body may either be fixed or tunable. In the latter case, the movement-imposing arrangement may include a suitable actuator and a mechanism allowing a user of the depilating device to adjust the moments of opening and closing the at least one hair-catching space of the depilating body during the rotations of the depilating body.

[0014] In conformity to what is known from WO

2021/130385 A1, it is advantageous if the actuating mechanism includes a force-inducing member which is compressible and extendable in the longitudinal direction and which is configured to determine the level of a force exerted by the actuating mechanism on the depilating body in the longitudinal direction when the size of the force-inducing member in the longitudinal direction is varied while the at least one hair-catching space of the depilating body is in a closed condition.

[0015] As explained earlier, by having a force-inducing member in the actuating mechanism, it is achieved that the hair-clamping force is not determined by a force-displacement characteristic of compression and extension of the depilating body only, but also by a force-displacement characteristic of compression and extension of the force-inducing member, so that a configuration is obtained in which the design of the depilating body can be adapted so as to have optimal hair-catching functionality of the depilating body and in which the design of the force-inducing member can be adapted so as to have optimal hair-clamping functionality of the depilating body as well. The fact is that having the force-inducing member offers the possibility of letting the hair-clamping force in the depilating body mainly be determined by the force-inducing member of the actuating mechanism, so that the hair-clamping force is practically not influenced by the amount of hairs caught in the depilating body. In a conventional case of the hair-clamping force being determined by the constitution of the depilating body itself, the hair-clamping force increases with the number of hairs in the depilating body. This effect can be counteracted when the actuating mechanism is equipped with the force-inducing member, as in that case, there is no longer a need for the hair-clamping force to be directly determined at the position where the hairs are present in the depilating body. Instead, it is possible to use the force-inducing member for determining the level of a force exerted by the actuating mechanism on the depilating body in the longitudinal direction when the size of the force-inducing member in the longitudinal direction is varied while the at least one hair-catching space of the depilating body is in a closed condition, which force yields the hair-clamping force under the conditions as mentioned. Further, when the force-inducing member of the actuating mechanism is relied on for setting the level of the hair-clamping force in the depilating body, indeed, variations in dimensions of the depilating body due to tolerances are compensated for, so that a predetermined level of the hair-clamping force may always be realized in practice. Thus, on the basis of the invention, consistency of performance is increased when depilating devices are manufactured in mass amounts. The design of the force-inducing member can be adapted so as to have sufficient tolerance spread for the components to be produced via known and proven production techniques.

[0016] It is noted that in the context of the present description, a force-displacement characteristic of compression and extension is to be understood as a characteristic of a body indicating a relation between a level of force generated in the body and a level of displacement of the body in the form of extension or compression of the body or, stated the other way around, as a characteristic of a body indicating a level of force to be exerted on the body for producing a certain displacement of the body in the form of extension or compression of the body. The force-displacement characteristic of compression and extension of a body is also referred to as the stiffness of the body in case the body is of the type having resilient/elastic/flexible properties.

[0017] An advantageous effect of the hair-clamping force mainly being determined by the force-displacement characteristic of compression and extension of the optional force-inducing member instead of the force-displacement characteristic of compression and extension of the depilating body is especially obtained if the force-displacement characteristic of compression and extension of the force-inducing member is significantly stronger than a force-displacement characteristic of compression and extension of the depilating body. The fact is that in such a case, when the actuating mechanism acts to compress the depilating body, this is done with practically no force until the at least one hair-catching space of the depilating body is closed. From that moment on, the level of forces acting at the position of the depilating body in the longitudinal direction is determined by the force-inducing member on the basis of the force-displacement characteristic of compression and extension thereof, wherein the influence of the force-displacement characteristic of compression and extension of the depilating body on the level of the forces is only minimal. This has effect on the forces acting in the depilating body in the longitudinal direction and thereby on the chance of holding on to the hairs and not letting the hairs slip out of the at least one hair-catching space. It is noted that by a stronger force-displacement characteristic is meant a force-displacement characteristic relating higher force to the same displacement.

[0018] Another notable advantage of the application of a force-inducing member in the actuating mechanism of the depilating device is that this involves a possibility of adapting the operation of the depilating device to actual circumstances. For example, in a case of grease being present on skin, it is desirable to increase the hair-clamping force in order to compensate for the reduced friction force involved in such a case. In the context of the invention, this can be done if the force-inducing member is of a type having an adjustable force-displacement characteristic of compression and extension in the longitudinal direction. Thus, it is practical to equip the actuating mechanism with such a type of force-inducing member. With reference to the example of needing to increase the hair-clamping force, this involves adjustment of the force-displacement characteristic of compression and extension in such a way that a certain displacement involves a higher level of force.

[0019] The force-inducing member may be of any suit-

able type. In this first place, it is noted that the force-inducing member may be a passive force-inducing member, and may be of a type which is commonly denoted as resilient, elastic and/or flexible, wherein the force-inducing member may comprise a piece of resilient/elastic material such as rubber, or a spring, for example. In respect of the option of the force-inducing member comprising a spring, the spring may be of any suitable type, such as a coil spring which is normally closed or normally opened, and the option of adjusting the force-displacement characteristic of compression and extension of the force-inducing member may involve the depilating device comprising an adjusting mechanism configured to adjust the spring constant of the spring. According to a further advantageous option, the depilating device may comprise an adjusting mechanism configured to adjust pretension of the spring. In the second place, the force-inducing member may be an active force-inducing member designed to perform the force-inducing function in an activated, energized condition, and may comprise a solenoid, for example.

[0020] In a practical embodiment of the depilating device according to the invention, the actuating mechanism comprises two actuating members which are both movable in the longitudinal direction, a first one of the actuating members being at a position closer to the depilating body in the longitudinal direction than a second one of the actuating members, wherein the force-inducing member is at a position of coupling the actuating members to each other. In such a configuration, the first one of the actuating members may be arranged to directly contact the depilating body. Also, the actuating members are preferably rigid in comparison to the force-inducing member, in which case the force-displacement characteristic of compression and extension of the combination of the actuating members and the force-inducing member is determined by the force-displacement characteristic of compression and extension of the force-inducing member. Further, when the actuating mechanism comprises two actuating members as mentioned, it may be practical if each of the actuating members is bush-shaped and at a position for surrounding a portion of the drive shaft. Inducing the two different movements of the depilating body, i.e. the rotational movement and the longitudinal compressing/extending movement, by means of separate components contributes to the overall accuracy of the depilating device.

[0021] The depilating body may be of any suitable design. Practical examples are a linear coil spring and a linear arrangement of discs. The size of the depilating body in the longitudinal direction can be chosen freely, and the same is applicable to the number of hair-catching spaces. In the exemplary case of a coil spring, the number of windings may be chosen so as to be only two or an appropriate higher number, whatever the case may be. A small number of windings may be practical if the depilating device is intended to be used as a facial depilating device, as especially in such a case, it may be desired to prevent blockage of vision by the depilating body as much as possible and it may be appropriate for the depilating device to be capable of depilating only one hair or not many more hairs at a time. Further, in the exemplary case of a coil spring, it is possible to have a conventional circular cross-section of the spring's wire, but it is also possible to have another cross-section such as a square or rectangular cross-section in order to increase the range of hair lengths of hairs to be caught by the depilating body. The invention covers both the option of a coil spring being normally opened, in which case the actuating mechanism acts to actively compress the coil spring, and the option of a coil spring being normally closed, in which case the actuating mechanism acts to actively extend the coil spring.

[0022] In the case that the actuating mechanism comprises the two actuating members and the force-inducing member comprises a coil spring, it is practical if the coil spring extends between supporting surfaces of the actuating members in the longitudinal direction. Transfer of forces in the longitudinal direction may take place through the end points of the first and last coils of the coil spring, but as that leads to forces which are off-centre, it is advantageous if the supporting surfaces of the actuating members are oriented relative to the longitudinal direction according to the pitch angle of the coil spring. If this measure is applied, it is further advantageous if a rotation delimiting mechanism configured to delimit rotation of the actuating members relative to each other in a direction about the rotation axis is included in the depilating device. In this way, it is avoided that the supporting surfaces of the actuating members can be rotated relative to each other to a notable extent, which may otherwise be done by a user of the depilating device taking hold of at least one of the actuating members, assuming a design of the depilating device in which at least one of the actuating members is accessible from outside of the depilating device. The fact is that as a result of the supporting surfaces of the actuating members being oriented relative to the longitudinal direction according to the pitch angle of the coil spring, rotation of the supporting surfaces relative to each other would lead to relative displacement of the supporting surfaces and thereby of disturbance of the longitudinal settings of the depilating device and the longitudinal forces associated therewith, including the hair-clamping force. Also, the longitudinal dimension of the at least one hair-catching space could be decreased, which involves a lower chance of catching hairs to be pulled out of the skin.

[0023] In a practical embodiment, the rotation delimiting mechanism comprises at least one of stop surfaces at an actuating member and stop surfaces at the connecting arrangement. In order to not introduce friction during normal operation, it is advantageous if the rotation delimiting mechanism is designed such that the stop surfaces are not in contact with each other during normal operation. This can be achieved by designing the rotation delimiting mechanism such that in a default/rest position

of the rotation delimiting mechanism, space is present between stop surfaces at the actuating member and stop surfaces at the connecting arrangement which are arranged so that they can be moved towards and away from each other in the direction about the rotation axis.

[0024] The concept of the supporting surfaces of the actuating members being oriented relative to the longitudinal direction according to the pitch angle of the coil spring can be put to practice independent from the concept of the depilating device being equipped with a connecting arrangement which is configured to connect the actuating mechanism to the drive shaft in a resilient fashion. In view thereof, the invention also relates to a depilating device comprising a depilating body which is rotatable about a rotation axis extending in a longitudinal direction with respect to the depilating body and which is provided with at least one hair-catching space, wherein the size of the at least one hair-catching space in the longitudinal direction is variable through compression and extension of the depilating body in the longitudinal direction, and an actuating mechanism configured to act on the depilating body so as to cause compression and extension of the depilating body in the longitudinal direction during rotational movement of the depilating body about the rotation axis, wherein the actuating mechanism includes a force-inducing member which is compressible and extendable in the longitudinal direction and which is configured to determine the level of a force exerted by the actuating mechanism on the depilating body in the longitudinal direction when the size of the force-inducing member in the longitudinal direction is varied while the at least one hair-catching space of the depilating body is in a closed condition, wherein the actuating mechanism comprises two actuating members which are both movable in the longitudinal direction, a first one of the actuating members being at a position closer to the depilating body in the longitudinal direction than a second one of the actuating members, wherein the force-inducing member is at a position of coupling the actuating members to each other, wherein the force-inducing member comprises a coil spring, wherein the coil spring extends between supporting surfaces of the actuating members in the longitudinal direction, and wherein the supporting surfaces of the actuating members are oriented relative to the longitudinal direction according to the pitch angle of the coil spring. Among other things, the above-mentioned option of having the rotation delimiting mechanism is equally applicable to the depilating device according to this definition.

[0025] The above-described and other aspects of the invention will be apparent from and elucidated with reference to the following detailed description of various embodiments of a depilating device comprising a depilating body and an actuating mechanism configured to act on the depilating body so as to cause hair-catching spaces of the depilating body to continually open and close during operation of the depilating device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The invention and aspects of relevant background art will now be explained in greater detail with reference to the figures, in which equal or similar parts are indicated by the same reference signs, and in which:

Fig. 1 is a diagrammatic sectional view of an assembly of components of an example of the depilating device known from WO 2021/130385 A1;
Fig. 2 is a diagrammatic sectional view of an assembly of components of a depilating device according to a first alternative embodiment;
Fig. 3 diagrammatically shows a leaf spring which is part of the depilating device according to the first alternative embodiment, and a sectional view of the drive shaft extending through a central hole of the leaf spring;
Fig. 4 diagrammatically shows a perspective view of the leaf spring, a portion of the drive shaft, and a cam follower attached to the leaf spring;
Fig. 5 illustrates a tilted orientation of the cam follower relative to the drive shaft;
Fig. 6 diagrammatically shows a sectional view of a portion of the drive shaft, a cam arranged around the drive shaft and a wheel of the cam follower rolling on a track of the cam;
Fig. 7 is a diagrammatic sectional view of an assembly of components of a depilating device according to a second alternative embodiment;
Fig. 8 diagrammatically shows a spring arrangement which is part of the depilating device according to the second alternative embodiment;
Fig. 9 diagrammatically shows a perspective view of the spring arrangement and a wheel which is held by the spring arrangement;
Fig. 10 diagrammatically shows a perspective view of the spring arrangement, the wheel and a cam having a track on which the wheel is guided;
Figs. 11 and 12 diagrammatically show different appearances of a hinging lever mechanism which can be applied in the depilating device as a movement-imposing arrangement;
Fig. 13 is a diagrammatic sectional view of an assembly of components of a depilating device according to a third alternative embodiment;
Fig. 14 diagrammatically shows a cross-section of magnets which are part of a magnetic drive system of the depilating device according to the third alternative embodiment;
Figs. 15-19 diagrammatically show different examples of alternative outlines of a coil spring intended to be used as the depilating body of the depilating device;
Fig. 20 diagrammatically shows a perspective view of a wave spring which is suitable to be used as the depilating body of the depilating device;
Figs. 21-23 diagrammatically show different exam-

ples of alternative distributions of open and closed windings in a coil spring intended to be used as the depilating body of the depilating device;

Fig. 24 diagrammatically shows a perspective view of end portions of coil springs;

Fig. 25 diagrammatically shows a perspective view of a portion of an element configured to contact an end of a coil spring intended to be used as the depilating body of the depilating device;

Fig. 26 diagrammatically shows a partially sectional view of the portion of the element shown in Fig. 25 and the coil spring as contacted by the element;

Fig. 27 diagrammatically shows a perspective view of a coil spring intended to be used as the depilating body of the depilating device and datum planes for illustrating where an outer coil ends in relation to a full coil;

Fig. 28 diagrammatically shows a portion of a pushing bush, the depilating body, a central shaft, an outline of the skin, and a hair;

Figs. 29 and 30 diagrammatically show views of a central shaft provided with recesses;

Fig. 31 diagrammatically shows a perspective view of the central shaft provided with recesses and the depilating body as mounted on the central shaft;

Fig. 32 illustrates a number of possible alternatives of the design of the central shaft provided with recesses;

Figs. 33 and 34 are a diagrammatic perspective view and a diagrammatic sectional view, respectively, of an assembly of components of an embodiment of a depilating device according to a fourth alternative embodiment;

Fig. 35 illustrates how the design of supporting surfaces of a coil spring included in an actuating mechanism which is part of the depilating device according to the fourth alternative embodiment can be adapted to the design of the coil spring; and

Figs. 36-38 illustrates aspects of a rotation delimiting mechanism which is also part of the depilating device according to the fourth alternative embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0027] Fig. 1 illustrates an example of the depilating device 1 known from WO 2021/130385 A1. The depilating device 1 according to this example is a handheld device including a housing 100 for accommodating a number of components of the device. The housing 100 is diagrammatically depicted as a dashed rectangle in Fig. 1. The depilating device 1 may be intended for use as a facial depilating device 1, for example.

[0028] The depilating device 1 is configured to be used for the purpose of performing a hair removing operation on skin. In view thereof, the depilating device 1 comprises a depilating body 10 which is intended to actually interact with the hairs to be plucked from the skin. For the purpose of catching and clamping the hairs, the depilating body 10 is provided with at least one hair-catching space 11. The depilating body 10 is designed so as to be compressible and extendable in a longitudinal direction L, and may comprise a coil spring, for example. The longitudinal direction L is indicated by means of a double-headed arrow in Fig. 1. Further, the depilating body 10 is rotatable in the depilating device 1 about a rotation axis R extending in the longitudinal direction L.

[0029] Besides the depilating body 10, the depilating device 1 comprises a driving mechanism 20 which is configured to drive the depilating body so as to actually perform a rotational movement about the rotation axis R during operation of the depilating device 1. In the shown example, the driving mechanism 20 comprises a drive shaft 21 which is also rotatable about the rotation axis R and an electric motor 22 for driving the drive shaft 21, wherein the depilating body 10 is arranged on the drive shaft 21 at the position of an end portion of the drive shaft 21 so that when the drive shaft 21 is driven by the electric motor 22, the depilating body 20 rotates along with the drive shaft 21.

[0030] Further, the depilating device 1 comprises an actuating mechanism 30 which is configured to act on the depilating body 10 so as to vary the size of the depilating body 10 in the longitudinal direction L during rotational movement of the depilating body 10 about the rotation axis R. In the shown example, one end of the depilating body 10 is fixedly connected to the drive shaft 21 and has a fixed position in the longitudinal direction L as a result thereof. In this configuration, the actuating mechanism 30 is arranged so as to interact with the other end of the depilating body 10 for the purpose of displacing the other end of the depilating body 10 with respect to the drive shaft 21 in the longitudinal direction L. In the following, the first-mentioned end of the depilating body 10 will be referred to as fixed end of the depilating body 10, and the other end of the depilating body 10 will be referred to as movable end of the depilating body 10.

[0031] The actuating mechanism 30 comprises a first actuating member 31 which is shaped like a bush extending in the longitudinal direction L, and which is arranged to surround a portion of the drive shaft 21 adjacent to the end portion supporting the depilating body 10, wherein the first actuating member 31 is slidable on the drive shaft 21 in the longitudinal direction L and is positioned so as to contact the movable end of the depilating body 10. Further, the actuating mechanism 30 comprises a second actuating member 32 which is shaped like a bush extending in the longitudinal direction L, and which is arranged to surround a portion of the drive shaft 21 which is further away from the depilating body 10 in the longitudinal direction L than the portion of the drive shaft 21 surrounded by the first actuating member 31, wherein the second actuating member 32 is also slidable arranged on the drive shaft 21 in the longitudinal direction L. Still further, the actuating mechanism 30 comprises a force-inducing member 33 which is at a position of coupling the actuating members 31, 32 to each other, i.e. a

position between the actuating members 31, 32 in the longitudinal direction L. In the shown example, the force-inducing member 33 comprises a coil spring which is arranged so as to surround the drive shaft 21, which coil spring may be a normally-closed coil spring or a normally-opened coil spring. The force-inducing member 33 is covered by a cylindrical cover 34 surrounding the force-inducing member 33 and overlapping with end portions of the actuating members 31, 32 as well, wherein the cylindrical cover 34 is connected to the second actuating member 32.

[0032] The present description is equally applicable when the force-inducing member 33 does not comprise a coil spring but another component or combination of components which is designed so as to be compressible and extendable in the longitudinal direction L. The actuating members 31, 32 and the force-inducing member 33 may be provided as three separate components joined together, which does not alter the fact that other options are possible as well, such as an option of the actuating members 31, 32 and the force-inducing member 33 being part of a single integral entirety having different zones, wherein an intermediate zone may have another force-displacement characteristic of compression and extension than the two other zones at the respective sides of the intermediate zone, or wherein only two zones of different flexibility are present. In the latter case, it may especially be practical if the first actuating member 31 is flexible and the second actuating member 32 is (more) rigid, wherein the actuating members 31, 32 are joined and the force-inducing member 33 is integrated in the first actuating member 31, as it were.

[0033] At the position of the other end of the second actuating member 32 than the end which is associated with the force-inducing member 33, a movement-imposing arrangement 40 including a cam 41 and cam follower 42 is present in the depilating device 1. The movement-imposing arrangement 40 is configured to impose movement in the longitudinal direction L on the second actuating member 32 when the drive shaft 21 rotates. To that end, one of the cam 41 and cam follower 42 has a fixed position in the depilating device 1, and the other one of the cam 41 and cam follower 42 is attached to the second actuating member 32. In the shown example, the cam follower 42 has the fixed position in the depilating device 1, and the cam 41 is attached to the second actuating member 32. Fig. 1 also illustrates an application of stops 23, 24 on the drive shaft 21 for delimiting the positions of the first actuating member 31 and the second actuating member 32, respectively, in the longitudinal direction L. The stops 23, 24 are projecting pins accommodated in respective longitudinal grooves in the actuating members 31, 32. In this way, the stops 23, 24 are functional to enabling transfer of torque from the drive shaft 21 to each of the actuating members 31, 32 while also allowing movement of the actuating members 31, 32 in the longitudinal direction L.

[0034] The length of the depilating body 10 may be chosen freely, depending on intended use of the depilating device 1. When the depilating body 10 comprises a coil spring, the number of windings of the coil spring can be chosen freely, and also the shape of the cross-section of the spring's wire can be chosen freely. Further, the material of the depilating body 10 can be treated material (material subjected to treatment such as mechanical treatment, chemical treatment or heat treatment) so as to have defined/improved grip of the depilating body 10 on the hairs. The depilating body 10 can be rotational symmetrical so that the depilating device 1 is effective in any position relative to skin to be subjected to a depilating action. The drive shaft 21 may be connected directly to the electric motor 22, or through a suitable gearbox system, for example.

[0035] With reference to the above explanation of design aspects of the depilating device 1, it is now described how the various components of the depilating device 1 function to enable the depilating device 1 to perform a depilating action during operation thereof. Operation of the depilating device 1 involves actuation of the electric motor 22, as a result of which the drive shaft 21 is driven so as to rotate about the rotation axis R. The rotational movement of the drive shaft 21 causes both a rotational movement of the depilating body 10 about the rotation axis R and cyclic variation of the size of the depilating body 10 in the longitudinal direction L. The rotational movement of the depilating body 10 about the rotation axis R follows directly from the arrangement of the depilating body 10 on the drive shaft 21. The process of alternately causing compression and extension of the depilating body 10 in the longitudinal direction L follows from the movement-imposing arrangement 40 dictating the position of the second actuation member 32 in the longitudinal direction L. The fact is that as the drive shaft 21 rotates about the rotation axis R, the position of the cam 41 of the movement-imposing arrangement 40 in the longitudinal direction L is varied under the influence of contact to the cam follower 42, and so is the position of the second actuating member 32 in the longitudinal direction L.

[0036] As long as the at least one hair-catching space 11 of the depilating body 10 is not in the closed condition, the variation of the position of the second actuating member 32 brings about a similar variation of the position of the first actuating member 31, through the force-inducing member 33. On the basis of the fact that the first actuating member 31 acts on the depilating body 10, rotation of the drive shaft 21 about the rotation axis R eventually brings about variation of the position of the movable end of the depilating body 10 in the longitudinal direction L, besides the rotation of the depilating body 10 about the rotation axis R. The displacement path followed by the movable end of the depilating body 10 in the process is determined by the design of the movement-imposing arrangement 40, and so is the relation between the number of times the depilating body 10 is compressed and extended per revolution. When the at least one hair-catch-

ing space 11 of the depilating body 10 is closed, variation of the position of the movable end of the depilating body 10 and the position of the first actuating member 31 is no longer allowed, and the second actuating member 32 performs a movement in the longitudinal direction L relative to the first actuating member 31, which relative movement is allowed due to the presence of the force-inducing member 33 in the actuating mechanism 30. In the process, a force exerted on the depilating body 10 in the longitudinal direction L by the actuating mechanism 30 is determined by the constitution of the force-inducing member 33, particularly the force-displacement characteristic of compression and extension of the force-inducing member 33, and it is this force that determines a hair-clamping force at the position of the hair-catching space 11.

[0037] As a result of the cycle of compressing and extending the depilating body 10 in the longitudinal direction L, the size of the at least one hair-catching space 11 in the depilating body 10 is alternately reduced and increased in the longitudinal direction L, such that the hair-catching space 11 is alternately put to the above-mentioned closed condition and an opened condition. When the depilating body 10 is held at a position close to skin from which hairs protrude, hairs are caught in the hair-catching space 11 during a period that the condition of the hair-catching space 11 changes from the opened condition to the closed position. When the hair-catching space 11 is in the closed position, the hairs are fixed in place in the hair-catching space 11 under the influence of a clamping force acting on the hairs in the longitudinal direction L. Assuming that the hair-clamping force is higher than the holding force exerted on the hairs at the position of the skin, the hairs are pulled out of the skin as a result of the rotational movement of the depilating body 10. On the basis of the presence of the force-inducing member 33 in the actuating mechanism 30 of the depilating device 1, it is possible to have an accurately defined hair-clamping force under all circumstances, and also to compensate for manufacturing tolerances of the depilating body 10, while the design of the depilating body 10 can be chosen so as to achieve optimal hair catching.

[0038] The aspect of compensating for manufacturing tolerances of the depilating body 10 is advantageous because if the force-inducing member 33 would not be present in the depilating device 1, it might occur that the movement-imposing arrangement 40 still acts to put the at least one hair-catching space 11 to the closed position while the hair-catching space 11 has already reached the closed position, in which case forces acting in the depilating device 1 increase to unforeseen high levels, or it might occur that the movement-imposing arrangement 40 is already at a maximum position for compressing the depilating body 10 while the hair-catching space 11 is still not fully closed, in which case the depilating body 10 cannot be effective in performing its depilating function.

[0039] The aspect of allowing for having an accurately defined hair-clamping force under all circumstances is particularly obtained when the force-displacement characteristic of compression and extension of the force-inducing member 33 is significantly stronger than the force-displacement characteristic of compression and extension of the depilating body 10. In fact, in the shown example, it is sufficient if the force-displacement characteristic of compression and extension of the depilating body 10 is such that the depilating body 10 is capable of pushing back the components of the actuating mechanism 30 when the movement-imposing arrangement 40 offers space for doing so.

[0040] An advantageous option existing in the context of the depilating device 1 is an option of tuning the force-inducing member 33, i.e. adjusting the force-displacement characteristic of compression and extension of the force-inducing member 33, as such option allows for having different modes of the depilating device 1, wherein an appropriate one of the modes may be set in dependency on environmental conditions such as soiling of the skin with grease. Also, a possibility of setting pre-tension of the force-inducing member 33 to an appropriate value is feasible.

[0041] Notable aspects of the depilating device 1 known from WO 2021/130385 A1 are summarized as follows. A depilating device 1 comprises a depilating body 10 which is rotatable about a rotation axis R extending in a longitudinal direction L with respect to the depilating body 10 and which is provided with at least one hair-catching space 11. The depilating device 1 further comprises an actuating mechanism 30 configured to act on the depilating body 10 so as to cause compression and extension of the depilating body 10 in the longitudinal direction L during rotational movement of the depilating body 10 about the rotation axis R, for the purpose of varying the size of the at least one hair-catching space 11 of the depilating body 10 in the longitudinal direction L, wherein the actuating mechanism 30 includes a force-inducing member 31 which is compressible and extendable in the longitudinal direction L and which has a function in determining the level of a hair-clamping force in the depilating body 10.

[0042] In the foregoing, it is explained that it is possible to realize a link between the function of causing compression and extension of the depilating body 10 in the longitudinal direction L and the function of rotating the depilating body 10 in a mechanical way. In this respect, it is indicated that in the above-described known case of the depilating device 1 comprising a rotatable drive shaft 21 coupled to the depilating body 10 and bush-shaped actuating members 31, 32 surrounding respective portions of the drive shaft 21, it may be beneficial if the depilating device 1 comprises a movement-imposing arrangement 40 including a cam 41 and cam follower 42, wherein one of the cam 41 and cam follower 42 has a fixed position in the depilating device 1, and wherein the other one of the cam 41 and cam follower 42 is attached to the second actuating member 32. Further, it is indicat-

ed that in such a configuration, movement of the actuating members 31, 32 in the longitudinal direction L is automatically induced as the drive shaft 21 rotates, in a predetermined way following from the design of the cam 41 and cam follower 42.

[0043] A first further concept relates to possible details of the movement-imposing arrangement 40 including the cam 41 and the cam follower 42. In general, using such an arrangement 40 without any further measures involves disadvantages. The fact is that the total construction comprises several components all having their own tolerances. Due to height tolerances of the cam 41, and in combination with length tolerances of the actuating members 31, 32, using a mechanical cam drive principle for inducing a reciprocating movement of the actuating members 31, 32 while at the same time having rotary movement of the actuating members 31, 32 results in realizing more or less travel from open to close at the position of the depilating body 10. Also, more or less force on the depilating body 10 when the at least one hair-catching space 11 of the depilating body 10 is in the closed condition is obtained. Assuming that the depilating body 10 comprises a coil spring, if the force is too high, the coils of the spring will 'cut' the hairs before trying to pull out the hairs. If the force is too low, there is not enough friction between the coils of the spring and the hairs in order to effectively pull the hairs out of the skin. The concept embodied in the depilating device 1 known from WO 2021/130385 A1 involves a force-controlling solution in the form of the force-inducing member 33 arranged between the first actuating member 31 and the second actuating member 32. With reference to Figs. 2-6, details of a practical alternative to using a coil spring as the force-inducing member 33 will now be explained.

[0044] Figs. 2-6 relate to a depilating device 2 according to a first alternative embodiment, in which the force-inducing member 33 comprises a leaf spring 51, and in which the actuating mechanism 30 comprises a pushing bush 35 extending from the leaf spring 51 to the depilating body 10. In Fig. 2, it can be seen that the movement-imposing arrangement 40 in the form of a cam drive system is connected to the depilating body 10 via the leaf spring 51 to apply the force that is required to grab the hairs without cutting the hairs. An additional function of the leaf spring 51 is to enable rotation of the pushing bush 35 along with the drive shaft 21, and the leaf spring 51 can thereby be considered as part of a connecting arrangement 50 configured to connect the actuating mechanism 30 to the drive shaft 21 in a resilient fashion. This additional function of the leaf spring 51 can also be realized in a separate manner. To that end, the drive shaft 21 has a flat recessed surface portion 25, at least along a length surrounded by the leaf spring 51, as can be seen in Fig. 3.

[0045] Fig. 2 shows that the leaf spring 51 is arranged so as to encompass a portion of the drive shaft 21, at a position between the cam drive system 40 and the pushing bush 35 in the longitudinal direction L. Fig. 3 shows the leaf spring 51 as seen in the longitudinal direction L, and further shows a sectional view of the drive shaft 21 extending through a central hole of the leaf spring 51. Generally speaking, the leaf spring 51 is shaped like a disc having a circular outer periphery and being provided with appropriate slots and holes. In the shown example, the leaf spring 51 comprises two tabs 52, 53 contacting the flat recessed surface portion 25 of the drive shaft 21 and thereby enabling transfer of torque from the drive shaft 21 to the leaf spring 51. Further, in the shown example, the leaf spring 51 comprises two relatively thin arms 54, 55 which serve to connect a central part 56 of the leaf spring 51, i.e. a part inclusing the central hole and the tabs 52, 53 to an outer ring 57 of the leaf spring 51. At the position of the outer ring 57, the leaf spring 51 is provided with holes 58. A number of those holes 58 are intended for receiving screws or the like for interconnecting the leaf spring 51 and the pushing bush 35 and for enabling transfer of torque from the leaf spring 51 to the pushing bush 35. In the view as shown in Fig. 3, on the basis of the configuration of the arms 54, 55, especially in order to avoid buckling of the arms 54, 55, the intended direction of rotation is counter clockwise.

[0046] The functionality of applying the required hair-clamping force to the depilating body 10 is achieved by means of an additional part which is screwed to the leaf spring 51 at the position of another number of the holes 58 located in the outer ring 57 of the leaf spring 51. This part is shown in Fig. 4 and is a wheel holder 43 which is part of the cam follower 42 and which is configured to hold a wheel 44 which is also part of the cam follower 42 and which is configured to roll over the cam 41. During assembly of the depilating device 2, the leaf spring 51 is a little pre-tensioned. As a consequence of the application of the leaf spring 51, forces acting on the depilating body 10 and the remainder of the system will not remain linear during compression of the depilating body 10. The fact is that when the system is in the position of applying hair-clamping force to the depilating body 10, the leaf spring 51 is deformed in a non-symmetrical manner so that the wheel 44 tilts. An example of the tilted orientation of the wheel 44 thus obtained is illustrated in Fig. 5. Due to the tilted orientation of the wheel 44, a sideward force is induced that acts from the wheel 44 to the wheel holder 43. This leads to undesired extra friction. In order to compensate for this effect and to avoid generation of the sideward force, it is proposed to provide the cam 41 with a banked track 45, that is to say, to have a tilted orientation of the track 45 of the cam 41, as illustrated in Fig. 6.

[0047] In Fig. 6, the wheel 44 is shown at a position on a side of the cam 41 which is associated with the opened condition of the at least one hair-catching space 11 of the depilating body 10. When the wheel 44 is at that position, there is little pretension and less deformation of the leaf spring 51. However, when the wheel 44 is at the opposite side of the cam 41, there is more pretension for pretensioning the depilating body 10 to such an extent that a sufficient level of hair-clamping force is obtained.

In that case, the leaf spring 51 needs to transfer more force and will therefore deform more. As a consequence, the wheel holder 43 and the wheel 44 tilt even more, and in view thereof, the track 45 of the cam 41 is even more tilted at the opposite side of the cam 41.

[0048] It follows from the forgoing that according to the first further concept, the force-inducing member 33 comprises a leaf spring 51, and that the cam follower 42 is attached to the leaf spring 51. In order to prevent frictional forces which would otherwise follow from deformation of the leaf spring 51 and an associated tilted orientation of the wheel holder 43 and the wheel 44 of the cam follower 42, the track 45 of the cam 41 has a tilted orientation instead of a perpendicular orientation to the rotation axis R, which tilted orientation may vary in a direction around the rotation axis R so as to be adapted to various deformation degrees of the leaf spring 51 at different positions in the direction around the rotation axis R, as explained. In this way, it can be achieved that the forces acting at the position of the wheel 44 on the track 45 of the cam 41 are always perpendicular to the track 45. Beneficial effects are that power loss of the drive system due to friction can be kept to a minimum and that wear of an outer peripheral surface of the wheel 44 and its counter-surface in the wheel holder 43 can be kept to a minimum as well so that travel of the wheel 44 in the longitudinal direction L and thereby the level of the hair-clamping force are preserved throughout the lifetime of the depilating device 2.

[0049] It is noted that the present disclosure includes variations of the leaf spring 51 which can be readily conceived by a person skilled in the art, such as variations relating to the number of screw holes 58 in the leaf spring 51. The concept of a cam 41 having a tilted track 45 can be applied in any context where a cam drive system is used and the cam follower 42 may be subjected to tilting influences.

[0050] A second further concept relates to an alternative to using a generally disc-shaped spring leaf 51 in the depilating device and providing the cam 41 with a banked track 45. In this respect, relevant details of a depilating device 3 according to a second alternative embodiment are now explained with reference to Figs. 7-10. A notable difference between the depilating device 3 according to the second alternative embodiment and the depilating device 2 according to the first alternative embodiment relates to the design of the connecting arrangement 50 of the depilating device 2 and resides in the fact that the leaf spring 51 of the depilating device 2 according to the first alternative embodiment is replaced by a spring arrangement 60 including two leaf springs 61, 62 which are coupled together in a rectangular shape. When it comes to operation of the cam drive system 40, it is noted that the spring arrangement 60 functions as a preloaded spring which forces the wheel 44 onto the track 45 of the cam 41 whereby the wheel 44 is prevented from losing contact to the track 45. As will become apparent from the following, the spring arrangement 60 is configured to not only hold the wheel 44 against the track 45 of the cam 41, but to also hold the wheel 44 parallel to the track 45.

[0051] The spring arrangement 60 is diagrammatically shown in Fig. 8 in order to illustrate that the two leaf springs 61, 62 of the spring arrangement 60 are coupled at the position of one corner of the rectangular shape, and also to the supporting structure, which is the pushing bush 35 in the case of the depilating device 3. The wheel 44 is fitted in the diagonally opposite corner. The cross-section of the two springs 61, 62 is such that the springs 61, 62 will bend predominantly in or close to the corner areas and realize a parallel movement of the wheel 44 as indicated by means of a double-headed arrow in Fig. 8.

[0052] Figs. 9 and 10 show perspective views of the spring arrangement 60 and the wheel 44 which is held by the spring arrangement 60, wherein Fig. 10 also shows the cam 41 and illustrates how the wheel 44 rolls over the track 45 of the cam 41. The two springs 61, 62 act as a parallellogram when the spring arrangement 60 is clamped at the position of a clamping area 63 where screw holes 64 are provided for enabling the spring arrangement 60 to be connected to the pushing bush 35 by means of screws. To avoid buckling of one of the leaf springs 61, 62 and/or joint bending of the two leaf springs 61, 62, the leaf springs 61, 62 are designed such as to ensure that bending only occurs in designated sections close to the clamping area 63 at one side and close to the wheel 44 at the other side. These designated sections act as imaginary pivot points as a result of which the general orientation of the wheel 44 is preserved throughout an entire round on the track 45 of the cam 41.

[0053] It follows from the forgoing that according to the second further concept, the wheel 44 of the cam follower 42 is held by a spring arrangement 60 including two interconnected leaf springs 61, 62 in parallellogram configuration. In particular, the spring arrangement 60 is designed such that tilting of the wheel 44 is avoided and it is possible to have a conventional, non-banked design of the track 45 of the cam 41. Various embodiments of the spring arrangement 60 are feasible, including an embodiment in which the spring arrangement 60 is designed as a single component, existing only of a single bent leaf spring.

[0054] A third further concept relates to an alternative of the cam drive system for dictating the movement of the pushing bush 35 in the longitudinal direction L. The applied force between the wheel 44 of the cam follower 42 and the track 45 of the cam 41 that needs to be provided is linked to the required hair-clamping force in the depilating body 10. Further, forces from other drive elements need to be overcome. Expecially the link to the hair-clamping force may probably give rise to a situation in which peak torque demand and cam load in the longitudinal direction L via the wheel 44 are so high that excessive wear is generated over the lifetime of the depilating device. In view thereof, another drive system is provided, with the specific goal of reducing the overall cam force in order to reduce friction and to thereby reduce

wear. In addition, sound production can be reduced when less friction and thereby less torque are needed.

[0055] With reference to Figs. 11, 12, it is noted that the present drive system comprises a hinging lever mechanism 70 which is configured to translate the required hair-clamping force and required movement in the longitudinal direction L into a radial force, i.e. a force in a direction which is perpendicular to the longitudinal direction L, and movement in the longitudinal direction L with a certain ratio. To that end, the hinging lever mechanism 70 comprises a drive shaft portion 71 and a radial cam 72 arranged on the drive shaft portion 71. The drive shaft portion 71 extends through two spaced sleeve elements 73, 74, wherein the drive shaft portion 71 is rotatable in both of the sleeve elements 73, 74, and wherein one of the spaced sleeve elements 73, 74, namely an output sleeve element 73 which is shown at the top side of Figs. 11, 12, which is at the depilating body side of the hinging lever mechanism 70, and which is connectable to the pushing bush 35 such as through an axial bearing, is slidable on the drive shaft portion 71 in the longitudinal direction L. The other sleeve element 74 is referred to as input sleeve element 74 and is under the influence of a pretensioned spring 33 acting to subject the input sleeve element 74 to force acting in the longitudinal direction, towards the output sleeve element 73. The two sleeve elements 73, 74 are interconnected through a lever system 75 comprising two lever arms 76, 77 which are hingably connected to each other. The lever system 75 supports a roller element 78 which is pressed against the radial cam 72 by means of a suitable mechanism configured to exert force on the roller element 78 in the direction perpendicular to the longitudinal direction L, which mechanism may comprise a leaf spring 79 as shown, for example.

[0056] On the basis of the above-described layout of the hinging lever mechanism 70, it is achieved that as the drive shaft portion 71 rotates, movement of the roller element 78 in the direction perpendicular to the longitudinal direction L is induced, in a way that is determined by the outline of the radial cam 72. In the process, the lever system 75 is moved between a most outstretched configuration as shown in Fig. 11 and a most bent configuration as shown in Fig. 12, and the output sleeve element 73 is alternately pulled towards and pushed away from the input sleeve element 74. The most outstretched configuration of the lever system 75 is associated with the closed condition of the at least one hair-catching space 11 of the depilating body 10, and the most bent configuration of the lever system 75 is associated with the opened condition of the at least one hair-catching space 11 of the depilating body 10. In the most bent configuration of the lever system 75, it is a preload force from the depilating body 10 that acts on the lever system 75 from the depilating body side. As the lever system 75 is made to move from the most bent configuration to the most outstretched configuration, the hair-clamping force is added at a certain point and increases until the most outstretched configuration has actually been reached.

[0057] The above-mentioned ratio with which the hinging lever mechanism 70 translates the required hair-clamping force and required movement in the longitudinal direction L into a radial force and movement in the longitudinal direction L is dependent on the lengths of the lever arms 76, 77 and the cam design with varying diameters of the radial cam 72. It is the pretensioned spring acting on the input sleeve element 74 which provides a force that is used in generating the hair-clamping force as required. The spring characteristics of both this pretensioned spring and the leaf spring 79 pressing the roller element 78 against the radial cam 72 can be chosen so that appropriate dynamics and functionalies can be obtained.

[0058] It follows from the forgoing that according to the third further concept, a hinging lever mechanism 70 is applied as the movement-imposing arrangement which is configured to impose movement in the longitudinal direction L on the pushing bush 35. By having this type of movement-imposing arrangement, wear behavior can be improved as compared to a cam drive system involving cam forces acting in the longitudinal direction. Various possibilities of applying the hinging lever mechanism 70 are feasible, including a possibility according to which the above-described setup of non-rotating lever arms 76, 77 and rotating cam 72 can be inverted, particularly a possibility according to which the lever arms 76, 77 rotate and the shaft 71 extends inside a 'negative' cam profile, i.e. a cam profile provided in an interior surface of a ring element arranged to surround the shaft 71.

[0059] A fourth further concept relates to an alternative way of realizing the intended operation of the depilating body 10 by enabling the compression and extension of the depilating body 10 and realizing the hair-clamping force required in the compressed condition of the depilating body 10. In this respect, relevant details of a depilating device 4 according to a third alternative embodiment are now explained with reference to Fig. 13. The design of the depilating device 4 according to the third alternative embodiment is aimed at reducing the number of components used in the device 4 and having a less complex configuration than the depilating device 1 shown in Fig. 1. The depilating device 4 according to the third alternative embodiment is without a cam drive system, to mention one difference to the depilating device 1 shown in Fig. 1, so that disadvantages of applying such a type of drive system such as rather high levels of absorbed energy and sound during operation, and also a rather high level of wear, can be alleviated.

[0060] In the depilating device 4 according to the third alternative embodiment, the cam drive system is replaced for a specific setup with permanent magnets as illustrated in Fig. 13 and as will be further explained below. At the right side of Fig. 13, a housing part 101 of the depilating device 4 is shown. This housing part 101 is configured to be at the interface of a depilating head 102 of the depilating device 4 and a handle of the depilating

device 4, wherein components such as the motor, gears, the battery and electronics are located in the housing part 101 and/or the handle. The drive shaft 21 is driven by an output shaft of the handle through a coupling part 26 which is accommodated by the housing part 101. The actuating mechanism 30 of the depilating device 4 according to the third alternative embodiment comprises a pushing bush 35, and the connecting arrangement 50 of the depilating device 4 comprises a bellows 36 of which one end, at the handle side thereof, is fixed to the drive shaft 21, and of which the other end, at the depilating body side thereof, is fixed to the pushing bush 35. The bellows 36 functions to transfer torque of the drive shaft 21 to the pushing bush 35 while realizing axial freedom of movement of the pushing bush 35.

[0061] The pushing bush 35 is rotatable along with the drive shaft 21 and is also slidable on the drive shaft 21. During the sliding movement, the pushing bush 35 acts to compress and release the depilating body 10. For the purpose of driving the pushing bush 35 to perform the sliding movement, the depilating device 4 according to the third alternative embodiment is equipped with a magnet assembly 80. In the shown example, the magnet assembly 80 comprises a tubular magnet 81 which is arranged on a part of the pushing bush 35 surrounding the bellows 36. In particular, a steel sleeve 82 is arranged on the part of the pushing bush 35 as mentioned, and the tubular magnet 81 is arranged on the steel sleeve 82. Further, the magnet assembly 81 comprises a steel tubular carrier part 83 which is fixed to the housing part 101 and which may have a function in shielding the environment from magnetic fields besides a function of carrying two tubular magnets 84, 85 arranged alongside each other. An inner diameter of the magnets 84, 85 in the carrier part 83, which will hereinafter be referred to as outer magnets 84, 85, is slightly larger than an outer diameter of the magnet 81 on the pushing bush 35, which will hereinafter be referred to as inner magnet 81, so that a small air gap is present between the outer magnets 84, 85 and the inner magnet 81. A dimension of the inner magnet 81 in the longitudinal direction L is comparable to a dimension of each of the outer magnets 84, 85 in the longitudinal direction L.

[0062] When the drive shaft 21 is rotated, the inner magnet 81 is rotated as well, whereas the outer magnets 84, 85 are stationary. All of the magnets 81, 84, 85 are provided as a single piece, one half of the piece having north polarity, and the other half of the piece having south polarity. The design of the magnets 81, 84, 85 is illustrated in Fig. 14, in which a cross-section of the inner magnet 81 and the outer magnet 85 which is at the handle side is shown, wherein the inner magnet 81 and the outer magnet 85 are positioned relative to each other as shown in Fig. 13. The outer magnets 84, 85 are arranged in a 180° rotated fashion so that their halves of different polarity extend alongside each other. It is a known fact that different polarities attract each other, while moving same polarities towards each other generates strong separation forces. On the basis of this principle, it is achieved that when the drive shaft 21 is rotated, a reciprocating movement of the pushing bush 35 in the longitudinal direction L is realized. Fig. 13 shows a first extreme position of the pushing bush 35, in which the north half of the inner magnet 81 fully faces the south half of the outer magnet 85 which is at the handle side and in which the south half of the inner magnet 81 fully faces the north half of that outer magnet 85. Starting from this first extreme position, it happens that as the inner magnet 81 rotates, a transition is made from this first extreme position to a second extreme position which is associated with a 180° turn of the inner magnet 81 and in which the north half of the inner magnet 81 fully faces the south half of the outer magnet 84 which is at the depilating body side and in which the south half of the inner magnet 81 fully faces the north half of that outer magnet 84, as a consequence of the particular 180° rotated arrangement of the outer magnets 84, 85 and the attracting forces and the repelling forces acting between the respective north and south halves of the inner magnet 81 and the outer magnets 84, 85. As the inner magnet 81 rotates further, a transition back to the first extreme position is made. The reciprocating movement of the inner magnet 81 in the longitudinal direction L between the two extreme positions is continually repeated as long as the drive shaft 21 is rotated.

[0063] The forces acting on the pushing bush 35 in the longitudinal direction L during rotation of the drive shaft 21 are determined by the magnetic flux. As mentioned in the foregoing, the pushing bush 35 acts on the depilating body 10 so as to compress and release the depilating body 10 and to provide the hair-clamping force. An advantage of using the magnet assembly 80 resides in the absence of mechanical friction, so that less driving torque is needed.

[0064] The design of the magnets 81, 84, 85 with the two halves of different polarity is not essential in the sense that alternatives are possible as long as there is a sequence of alternating polarities. Thus, it is also possible for the magnets 81, 84, 85 to comprise two quarters of north polarity and two quarters of south polarity, for example, wherein each of the quarters of north polarity is arranged between quarters of south polarity, as seen in the peripheral direction of the magnets 81, 84, 85, and wherein, consequently, each of the quarters of south polarity is arranged between quarters of north polarity.

[0065] Applying a magnet assembly 80 as a means for enabling the actuating mechanism 30 to act on the depilating body 10 in a way as envisaged can be done without applying a cam drive system, as suggested in the foregoing, but that does not alter the fact that the present concept also covers an option of applying both a magnetic drive system and a cam drive system. If such option is put to practice, it is advantageous to design the respective depilating device in such a way that the forces needed for operation of the depilating body 10 as intended are controlled by the magnetic drive system while

translation/displacement aspects are controlled by the cam drive system. The benefit is that the movement of compressing and extending of the depilating body 10 is much more controlled with less (micro-)vibration.

[0066] A fifth further concept relates to the depilating body 10. In the foregoing, a linear coil spring and a linear arrangement of discs are mentioned as practical examples of the depilating body 10. It can be derived from Fig. 1, for example, that when a coil spring is used, indeed, it may be practical if the coil spring is designed with a constant diameter along the length of the spring. However, a problem associated with applying such a coil spring as the depilating body 10 is that the coil spring is supposed to establish line contact to the skin to be subjected to a depilating action, but that in practice, irregular and non-flat appearance of the skin renders it difficult to realize the line contact as envisaged. In view thereof, alternative designs of the depilating body 10 are proposed. In this respect, Fig. 15 diagrammatically shows a perspective view of a conical coil spring, Fig. 16 illustrates a generally beehive-shaped coil spring, wherein the spring's beehive-outline is indicated by means of lines in the figure, Fig. 17 diagrammatically shows a perspective view of a generally barrel-shaped coil spring, and Fig. 18 diagrammatically shows a perspective view of a concave coil spring of which the outer diameter is smallest about halfway the length of the spring and increases in two directions towards the ends of the spring.

[0067] Further, it is noted that it is not necessary for the coil spring to be of the linear type. Instead, it is possible that the pitch of the coil spring differs along the length of the spring, as illustrated in Fig. 19 in which an example of a non-linear spring is shown. When the coil spring comes with different pitches, it is achieved that the spring is suitable for catching and clamping both relatively thick hairs and relatively thin hairs. This is relevant as the thickness of human hair is variable. The coil spring may comprise coils laying flat to each other or having varying distances between them. The chance of catching relatively thick hairs is larger at the position of a relatively large hair-catching space 11 as present at a relatively large pitch, whereas the chance of catching a number of relatively thin hairs in one go is larger at the position of a relatively small hair-catching space 11 as present at a relatively small pitch.

[0068] It follows from the foregoing that in case a coil spring is provided for use as the depilating body 10, it is not necessary for the coil spring to have a design in which the outer diameter of the coil spring is constant along the length of the spring, and it is not necessary for the coil spring to be of the linear type either.

[0069] Fig. 20 diagrammatically shows a perspective view of a wave spring. An option of the depilating body 10 comprising such a spring is covered by the present concept. Using a wave spring as shown involves the benefit of improved control of an even distribution of hair-clamping force between the clamping faces of the spring when the spring is in a fully compressed condition. Another benefit of using a wave spring resides in the fact that such a spring is capable of transferring torsional load. Wave springs may be provided as a coil, as shown in Fig. 20, but it is also possible for wave springs to be assembled from separate disc springs which are mechanically attached to each other by pin-and-hole connections or through welding, for example.

[0070] In view of the fact that the springs shown in Figs. 15-20 are intended to be used as the depilation body 10, the springs are referred to by means of reference numeral 10 in the figures. It will be understood that the present concept covers many other optional designs of the spring than the ones illustrated in Figs. 15-20.

[0071] A sixth further concept is also a concept which relates to the depilating body 10. In this respect, it is noted that the difference between the smallest length of the depilating body 10 in the compressed condition and the largest length of the depilating body 10 in the extended condition, which difference is also referred to as stroke, needs to be small if the depilating body 10 comprises a linear coil spring. The fact is that when a hair is caught in a tweezer of the depilating body 10, i.e. a portion of the depilating body 10 including a hair-catching space 11 and winding portions delimiting the hair-catching space 11, and that tweezer is near the movable end of the coil spring, both windings are moved in the direction of the fixed end of the coil spring when the spring is compressed to grap the hair and hold it while pulling it out of the skin. If the upward displacement as mentioned is 1.5 mm, for example, this might actually be longer than the hair which is caught. Thus, in such a case, it may happen that the hair has left the tweezer before the tweezer was able to apply the hair-clamping force to the hair. In general, it is true that the smaller the stroke, the shorter the hair that can be pulled out. Further, the length of the stroke is limited by mechanical aspects of the driving mechanism.

[0072] The longer the stroke, the more force will be needed for compressing and extending the coil spring and the more vibration will be generated, leading to wear, shorter battery life and nuisance to the user due to vibration in the hand and on the skin. This is another reason why it is beneficial to have a small stroke. However, a consequence of a small stroke is that it is possible to only use a small number of windings, which involves a very small length of the coil spring in the fully compressed condition of the spring, such as a length which is as small as about 2 mm. This is not appealing to users who would generally like to have an effective depilating system of sufficient length.

[0073] A further consideration in respect of the use of a linear coil spring as the depilating body 10 is that it may be practical if a diameter of an end portion of the actuating member contacting the movable end of the coil spring is somewhat larger than the outer diameter of the spring at the movable end. However, this means that skin which is subjected to a depilating action by means of the coil spring cannot directly touch the first one or two coils which

are near the movable end, so that the coil spring is less effective in its ability to catch (short) hairs at the position of those coils. Further, taking into account the fact that a practical value of the wire thickness of the coil spring may be in a range of about 0.2 to 1 mm, the coils are close to each other, probably closer to each other than hairs on human skin to each other. This implies that having two tweezers right next to each other might be less effective than relying on a first and a fifth tweezer, for example.

[0074] In view of the foregoing, embodiments of the depilating body 10 are proposed in which the depilating body 10 comprises a coil spring in which the pitch differs per winding or per set of windings. For example, it may be beneficial to have several windings produced with a pitch similar to the wire thickness. The coils then lay flat on each other, whereas in a different location of the coil spring, the pitch is larger. The tweezers are then either set further apart from at least one end of the coil spring or further apart from each other.

[0075] A first example of a coil spring in which the pitch differs per winding or per set of windings is illustrated in Fig. 21. The coil spring of this example has closed windings at the end of the spring which is intended to be the movable end. In this way, it is ensured that the skin will always contact the open windings. Further, by having the closed windings, it is achieved that the effective area seems to be larger and therefore the appearance of the coil spring can be perceived by a user as being attractive.

[0076] A second example of a coil spring in which the pitch differs per winding or per set of windings is illustrated in Fig. 22. The coil spring of this example has closed windings distributed over the total length of the spring, so that the tweezers are set further apart in order to cover a wider area over the skin. The distribution of the closed windings is different from the coil spring of the example illustrated in Fig. 21, but a total coil opening of the coil spring is the same.

[0077] A third example of a coil spring in which the pitch differs per winding or per set of windings is illustrated in Fig. 23. The coil spring of this example can be regarded as being a combination of the coil springs of the preceding two examples: from the end of the spring which is intended to be the movable end to the end which is intended to be the fixed end, the amount of closed windings between tweezers is reduced. In this way, a portion of the coil spring near the end which is intended to be the fixed end will be most effective in the sense that the tweezers are closer to each other. The coil spring is also capable of retracting hairs in an area near the end which is intended to be the movable end, but operation can be expected to be less effective and less precise at the position of this area than at the position of an area near the end which is intended to be the fixed end.

[0078] In view of the fact that the springs shown in Figs. 21-23 are intended to be used as the depilation body 10, the springs are referred to by means of reference numeral 10 in the figures. It will be understood that the present concept covers many other optional designs of the spring than the ones illustrated in Figs. 21-23, such as designs including a larger number of effective/open tweezers.

[0079] A seventh further concept is also a concept which relates to the depilating body 10. As explained in the foregoing, the depilating body 10 is compressed and extended during operation. Assuming that the depilating body 10 compresses a coil spring, the fact is that in order for a depilating action to function properly, the hair-clamping force needs to be evenly distributed along the entire periphery of the spring. If that is the case, indeed, the force of the coils of the coil spring acting on each other is the same at any angular position on the coil spring, i.e. at any position around the rotation axis R.

[0080] In general, a coil spring is made from a wire which has been wound so as to obtain the coil spring, and the wire has two ends. At each of the two ends, the coil spring is capable of contacting a plane which is perpendicular to the longitudinal direction L only through an end portion of the outer coil (i.e. end coil, first/last coil), and not through the entire outer coil as would be desirable so as to realize the even distribution of the hair-clamping force mentioned in the foregoing. Several measures are now proposed to alleviate this problem.

[0081] A first possible measure involves performing a grinding action on the outer coil so as to remove material from the outer coil and to thereby shape the outer coil such that the coil spring is capable of contacting a plane which is perpendicular to the longitudinal direction L through the entire outer coil. This possibility is illustrated in Fig. 24 in which the original appearance of an end portion of a coil spring is shown at the right side and the appearance of the end portion of the coil spring after grinding is shown at the left side.

[0082] A second possible measure involves adapting the design of the element which is supposed to contact an end of the coil spring. In particular, such an element can be provided with a recess of increasing depth in the peripheral direction as illustrated in Fig. 25, so that a support surface 37 of a outer coil of the coil spring is obtained which is oriented so as to follow the slanting orientation of the outer coil and to thereby be capable of establishing contact to the entire outer coil as illustrated in Fig. 26 in which a partially sectional view of the compressed coil spring 10 and a portion of the pushing bush 35 are shown. In fact, the depth of the recess as mentioned increases from zero to the thickness of the spring's wire. In the shown example, the pushing bush 35 is one of the elements intended to contact an end of the coil spring, while the coil cap located at the other end of the coil spring is the other of those elements.

[0083] A third possible measure involves taking into account certain requirements in the process of winding the spring's wire in order to manufacture the coil spring. In the context of the present concept, it has been found that on the basis of the flexibility of the coil spring and the associated capability of the coils to dislocate slightly from each other under the influence of force in the longitudinal direction L, the spring can be made to contact

a plane which is perpendular to the longitudinal direction along approximately half of the outer coil, namely when the outer coil is in a range of 60% to 90% of a full coil, preferably in a range of 70% to 80% of a full coil. This is illustrated in Fig. 27 in which a coil spring is shown with a datum plane of the partial outer coil and a datum plane of what would be an entire coil. In practical cases, the optimal coil percentage of the outer coil is dependent on several factors including total amount of coils in the coil spring, wire thickness, wire material properties and play of the inside of the coils towards the central shaft 21. It will be understood that realizing an even distribution of hair-clamping force along the entire periphery of the coil spring by simply making an appropriate choice in respect of the coil percentage of the outer coil constitutes a very interesting possibility that may be preferred over subjecting the spring to a grinding action and/or adapting the design of a contacting element.

[0084] In view of the fact that the springs shown in Figs. 24, 26 and 27 are intended to be used as the depilation body 10, the springs are referred to by means of reference numeral 10 in the figures.

[0085] An eighth further concept relates to the design of the central shaft 21 at the position of the depilating body 10.

[0086] When the depilating body 10 pressed on the skin in a depilating action, reaction forces exerted on the depilating body 10 by the skin are counteracted by the central shaft 21 inside the depilating body 10. With reference to Fig. 28 in which a portion of the pushing bush 35, the depilating body 10 in the form of a coil spring and the central shaft 21 are shown and in which an outline of the skin is indicated at the right side, it is noted that the presence of the central shaft 21 at the position of the depilating body 10 involves disadvantages.

[0087] In the first place, when a hair 200 is positioned in a hair-catching space 11 of the depilating body 10, as indicated in Fig. 28, the extent to which the hair 200 can extend inwardly in the depilating body 10 is limited by the central shaft 21. A practical value of the wire thickness is 0.3 mm and a practical value of the play of the inside of the coils towards the central shaft 21 is 0.1 mm. Hence, it may be so that in practice, a hair 200 will hit the central shaft 21 when it sticks between the coils of the depilating body 10 by a distance of about 0.4 mm. As a consequence, some hairs 200 cannot be grabbed tight enough for extracting them from the skin or hairs 200 will flex to a different location when hitting the shaft, out of the grabbing reach of the depilating body 10. Thus extraction is not optimal due to the interaction of the hairs 200 with the central shaft 21.

[0088] In the second place, extracted hairs, dirt picked up from the skin, make-up picked up from the skin, etc. accummulate between the central shaft 21 and the depilating body 10 and may get stuck there. The more the narrow gap between the central shaft 21 and the depilating body 10 gets clogged, the more difficult it gets to remove hairs 200.

[0089] In view of the foregoing, it is proposed to adapt the design of the central shaft 21 at the position of the depilating body 10, particularly to provide the respective portion of the central shaft 21 with recesses 27, as shown in Figs. 29 and 30. The recesses 27 may have a generally elongated shape so as to extend in the longitudinal direction L along the entire length of the central shaft 21 to be covered by the depilating body 10, as can be seen in Fig. 30. An appropriate number of the recesses 27 is three, but other numbers are possible as well, as long as the central shaft 21 is still capable of performing the function of supporting the depilating body 10. Fig. 31 shows how the depilating body 10 is mounted on the central shaft 21 having the recesses 27.

[0090] In Fig. 32, a number of alternative possibilities are illustrated. In the figure, the circles represent the depilating body 10 and the central items represent the cross-section of the central shaft 21 at the position of the depilating body 10. It can be seen that the less contact lines/areas of the central shaft 21 to the depilating body 10, the more space is available for hairs 200 to be grabbed and the more space is available for extracted hairs 200 to be stored.

[0091] By providing the central axis 21 with recesses 27, it is achieved that hairs 200 can stick in between the coils of the depilating body 10 further so that extraction effectiveness is increased. Extracted hairs 200 which are captured in the recesses 27 can be removed by the user with the help of a brush or the like after use of the depilating device.

[0092] A ninth further concept relates to the option of the actuating mechanism 30 comprising a first actuating member 31 and a second actuating member 32 with the force-inducing member 33 at a position of coupling the actuating members 31, 32 to each other, combined with the option of the force-inducing member 33 comprising a coil spring. In this respect, relevant details of a depilating device 5 according to a fourth alternative embodiment are now explained with reference to Figs. 33-38.

[0093] In the depilating device 5 according to the fourth alternative embodiment, the coil spring of the force-inducing member 33 extends between supporting surfaces 38, 39 of the actuating members 31, 32 in the longitudinal direction L. The force-inducing member 33 has two functions, namely a function in transfer of rotational torque in the depilating device 5, and a function in transfer of longitudinal force in the depilating device 5. In view thereof, the end points of the coil spring are arranged so as to push on tabs, as can be seen in respect of the end point which is present at the side of the first actuating member 31 in Fig. 33. As a consequence, the coil spring cannot have ground ends. According to an insight of the invention, if the supporting surfaces 38, 39 are oriented perpendicular to the longitudinal direction L, the longitudinal force transferred are off-centre, which causes introduction of sideward forces in the depilating device 5, which forces act on components of the depilating device 5 such as the drive shaft 21 and the bearing of the drive shaft

21. Consequently, the sideward forces cause an increase of friction between moving parts of the depilating device 5 and therefore the torque needed to drive those parts needs to be increased. This in turn involves disadvantageous effects such as additional wear and decreased battery life. In order to avoid such effects, the supporting surfaces 38, 39 are oriented relative to the longitudinal direction L according to the pitch angle α_p of the coil spring, as can be seen in Fig. 35.

[0094] On the basis of the adapted orientation of the supporting surfaces 38, 39, line contacts are obtained between the coil spring and the first actuating member 31 at the one end of the coil spring, and between the coil spring and the second actuating member 32 at the other end of the coil spring. Fig. 35 shows the coil spring in a state in which the coil spring is not compressed and therefore does not exert much force in the longitudinal direction L. However, when the depilating body 10 is in the compressed condition, the coil spring is also more compressed and the supporting surfaces 38, 39 rest against (part of) the first and last coils of the coil spring. The force in the longitudinal direction L is therefore more or even fully centered, so that the friction following from sideward forces is less than when only the end points of the coil spring would be used for transferring the force.

[0095] A consequence of the adapted orientation of the supporting surfaces 38, 39 is that when the end points of the coil spring do not rest against the tabs, which may happen when at least one of the actuating members 31, 32 is accessible from outside of the depilating device 5 and is twisted from a default/predetermined position by a user of the depilating device 5 for some reason or by accident, the actuating members 31, 32 are forced further away from each other, for as long as the ends of the coil spring slide over the supporting surfaces 38, 39. This relative displacement of the actuating members 31, 32 leads to a more compressed extended condition of the depilating body 10 and to higher longitudinal force in the compressed condition of the depilating body 10. The consequences are decreased chance of grabbing hairs due to less space between coils in the extended position of the depilating body 10, and increased chance of cutting hairs due to too much force between coils when grabbing hairs. Both consequences are undesirable, and therefore measures are taken to prevent rotation of the supporting surfaces 38, 39 relative to each other. In particular, these measures involve providing a rotation delimiting mechanism 90 configured to delimit rotation of the actuating members 31, 32 relative to each other in a direction about the rotation axis R.

[0096] Numerous possibilities exist when it comes to the design of the rotation delimiting mechanism 90. In the present example, use is made of the fact that the connecting arrangement 50 of the depilating device 5 comprises both a leaf spring 51 and a non-resilient connecting member 65 comprising two legs 66, 67, wherein ends of the respective legs 66, 67 are connected to the leaf spring 51 at the position of an outer peripheral area of the leaf spring 51. As illustrates in Figs. 36-38, wherein in Figs. 37 and 38 the coil spring of the force-inducing member 33 is omitted for the sake of clarity, the first actuating member 31 is provided with two end tabs 91, 92, and the non-resilient connecting member 65 is provided with two end tabs 93, 94 as well. Fig. 38 shows a perspective sectional view taken in a direction perpendicular to the longitudinal direction L at the level of the respective end tabs 91, 92, 93, 94.

[0097] Figs. 36-38 illustrate a default position of the rotation delimiting mechanism 90, in which the end tabs 91, 92 of the first actuating member 31 and the end tabs 93, 94 of the non-resilient connecting member 65 are at the same level on the drive shaft 21 in a direction about the rotation axis R, yet do not contact each other. In this way, it is avoided that the presence of the rotation delimiting mechanism 90 would add to friction during movement of the first actuating member 31 and the non-resilient connecting member 65 relative to each other in the longitudinal direction L during operation of the depilating device 5. However, when the first actuating member 31 is twisted to rotate about the rotation axis R, this movement is blocked as soon as relevant stop surfaces 95 at the side of the end tabs 91, 92 of the first actuating member 31 abut against relevant stop surfaces 96 at the side of the end tabs 93, 94 of the non-resilient connecting member 65. A further advantage of having the rotation delimiting mechanism 90 is that the rotation delimiting mechanism 90 also functions to avoid that the leaf spring 51 can be twisted out of shape and can be damaged or even broken as a result thereof. Also, in case the leaf spring 51 does break for some reason, the depilating device 1 can still function as the rotary movement of the various components of the device 1 is maintained on the basis of the presence of the rotation delimiting mechanism 90, albeit in a less optimal way.

[0098] As mentioned in the foregoing, the connecting arrangement 50 of the depilating device 5 comprises a combination of a leaf spring 51 and a non-resilient connecting member 65. The design of the leaf spring 51 is similar to the design of the leaf spring 51 as decribed in the context of the depilating device 2 according to the first alternative embodiment with reference to Fig. 3. The leaf spring 51 is arranged on the second actuating member 32, and the non-resilient connecting member 65 couples the outer peripheral area of the leaf spring 51 to the drive shaft 21 at a position that is more towards the depilating body 10. In the longitudinal direction L, the leaf spring 51 is held between the non-resilient connecting member 65 and supports on the second actuating member 32. When the position of the movement-imposing arrangement 40 is such that the depilating body 10 is in the extended condition, the leaf spring 51 is in a rest position, whereas when the position of the movement-imposing arrangement 40 is such that the depilating body 10 is in the compressed condition, the leaf spring 51 is deformed to some extent. The inclination of the leaf spring 51 to move back to the rest position supports the

process of putting the depilating body 10 from the compressed condition to the extended condition. In general, an advantage of using the leaf spring 51 is that friction is minimal and that only force is needed to deform the leaf spring 51 under the influence of movement in the longitudinal direction L.

[0099] The present disclosure includes any possible combination of the above-described further concepts which can be readily conceived by a person skilled in the art. The present disclosure also includes any possible application of one or more of the above-described further concepts in the general context of a depilating device comprising i) a depilating body 10 which is rotatable about a rotation axis R extending in a longitudinal direction L with respect to the depilating body 10 and which is provided with at least one hair-catching space 11, wherein the size of the at least one hair-catching space 11 in the longitudinal direction L is variable through compression and extension of the depilating body 10 in the longitudinal direction L, and ii) an actuating mechanism 30 configured to act on the depilating body 10 so as to cause compression and extension of the depilating body 10 in the longitudinal direction L during rotational movement of the depilating body 10 about the rotation axis R and to realize a hair-clamping force in the depilating body 10 in the longitudinal direction L when the at least one hair-catching space 11 of the depilating body 10 is in a closed condition.

[0100] It will be clear to a person skilled in the art that the scope of the invention is not limited to the examples discussed in the foregoing, but that several amendments and modifications thereof are possible without deviating from the scope of the invention as defined in the attached claims. It is intended that the invention be construed as including all such amendments and modifications insofar they come within the scope of the claims or the equivalents thereof. While the invention has been illustrated and described in detail in the figures and the description, such illustration and description are to be considered illustrative or exemplary only, and not restrictive. The invention is not limited to the disclosed embodiments. The drawings are schematic, wherein details which are not required for understanding the invention may have been omitted, and not necessarily to scale.

[0101] Variations to the disclosed embodiments can be understood and effected by a person skilled in the art in practicing the claimed invention, from a study of the figures, the description and the attached claims. In the claims, the word "comprising" does not exclude other steps or elements, and the indefinite article "a" or "an" does not exclude a plurality. Any reference signs in the claims should not be construed as limiting the scope of the invention.

[0102] Elements and aspects discussed for or in relation with a particular embodiment may be suitably combined with elements and aspects of other embodiments, unless explicitly stated otherwise. Thus, the mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

[0103] The terms "comprise" and "include" as used in this text will be understood by a person skilled in the art as covering the term "consist of". Hence, the term "comprise" or "include" may in respect of an embodiment mean "consist of', but may in another embodiment mean "contain/have/be equipped with at least the defined species and optionally one or more other species".

[0104] Notable aspects of the invention are summarized as follows. A depilating device 2, 3, 4 comprises a depilating body 10 which is rotatable about a rotation axis R extending in a longitudinal direction L with respect to the depilating body 10, an actuating mechanism 30 configured to act on the depilating body 10 so as to cause compression and extension of the depilating body 10 in the longitudinal direction L during rotational movement of the depilating body 10 about the rotation axis R, and a driving mechanism 20 configured to drive the depilating body 10 and to also drive the actuating mechanism 30. The actuating mechanism 30 is connected to a drive shaft 21 of the driving mechanism 20 in a resilient fashion, such as through at least one leaf spring 51, 61, 62, which contributes to minimizing friction and noise in the depilating device 2, 3, 4 and which may also support one of compression and extension of the depilating body 10.

Claims

1. Depilating device (2, 3, 4, 5), comprising:

- a depilating body (10) which is rotatable about a rotation axis (R) extending in a longitudinal direction (L) with respect to the depilating body (10) and which is provided with at least one hair-catching space (11), wherein the size of the at least one hair-catching space (11) in the longitudinal direction (L) is variable through compression and extension of the depilating body (10) in the longitudinal direction (L),
- an actuating mechanism (30) configured to act on the depilating body (10) so as to cause compression and extension of the depilating body (10) in the longitudinal direction (L) during rotational movement of the depilating body (10) about the rotation axis (R),
- a driving mechanism (20) configured to drive the depilating body (10) so as to perform the rotational movement about the rotation axis (R), wherein the driving mechanism (20) comprises a rotatable drive shaft (21) coupled to the depilating body (10) for imposing rotational movement on the depilating body (10), and wherein the driving mechanism (20) is configured to also drive the actuating mechanism (30) so as to cause compression and extension of the depilating body (10) in the longitudinal direction (L), and

- a connecting arrangement (50) configured to connect the actuating mechanism (30) to the drive shaft (21) in a resilient fashion.

2. Depilating device (2, 3, 4, 5) according to claim 1, wherein the connecting arrangement (50) comprises at least one resilient member (36, 51, 61, 62).

3. Depilating device (2, 3, 5) according to claim 2, wherein the connecting arrangement (50) comprises at least one leaf spring (51, 61, 62).

4. Depilating device (3) according to claim 3, wherein the connecting arrangement (50) comprises a spring arrangement (60) including two leaf springs (61, 62) which are coupled together in a rectangular shape.

5. Depilating device (2, 3, 5) according to claim 3 or 4, wherein the at least one leaf spring (51, 61, 62) is directly fixed to both the actuating mechanism (30) and the drive shaft (21).

6. Depilating device (2, 5) according to any of claims 3-5, wherein the at least one leaf spring (51, 61, 62) is shaped like a disc having a circular outer periphery and being provided with a central hole and slots.

7. Depilating device (5) according to any of claims 2-6, wherein the connecting arrangement (50) further comprises at least one non-resilient connecting member (65).

8. Depilating device (5) according to claim 7 insofar as dependent on claim 6, wherein the non-resilient connecting member (65) comprises at least two legs (66, 67), and wherein ends of the respective legs (66, 67) are connected to a leaf spring (51, 61, 62) at the position of an outer peripheral area of the leaf spring (51, 61, 62).

9. Depilating device (2, 3, 4, 5) according to any of claims 1-8, wherein one end of the depilating body (10) is a fixed end having a fixed position in the longitudinal direction (L) and the other end of the depilating body (10) is a movable end having a variable position in the longitudinal direction (L), and wherein the actuating mechanism (30) is configured to act on the depilating body (10) at the side of the movable end thereof.

10. Depilating device (2, 3, 5) according to any of claims 1-9, comprising a movement-imposing arrangement (40) including a cam (41) and cam follower (42), wherein one of the cam (41) and cam follower (42) has a fixed position in the depilating device (2, 3, 4, 5), and wherein the other one of the cam (41) and cam follower (42) is integrated in or fixed to one of the actuating mechanism (30) and the connecting arrangement (50).

11. Depilating device (2, 3, 4, 5) according to any of claims 1-10, wherein the actuating mechanism (30) includes a force-inducing member (33) which is compressible and extendable in the longitudinal direction (L) and which is configured to determine the level of a force exerted by the actuating mechanism (30) on the depilating body (10) in the longitudinal direction (L) when the size of the force-inducing member (33) in the longitudinal direction (L) is varied while the at least one hair-catching space (11) of the depilating body (10) is in a closed condition.

12. Depilating device (5) according to claim 11, wherein the actuating mechanism (30) comprises two actuating members (31, 32) which are both movable in the longitudinal direction (L), a first one (31) of the actuating members (31, 32) being at a position closer to the depilating body (10) in the longitudinal direction (L) than a second one (32) of the actuating members (31, 32), wherein the force-inducing member (33) is at a position of coupling the actuating members (31, 32) to each other.

13. Depilating device (5) according to claim 12, wherein the force-inducing member (33) comprises a coil spring, wherein the coil spring extends between supporting surfaces (38, 39) of the actuating members (31, 32) in the longitudinal direction (L), and wherein the supporting surfaces (39, 39) of the actuating members (31, 32) are oriented relative to the longitudinal direction (L) according to the pitch angle of the coil spring.

14. Depilating device (5) according to claim 13, comprising a rotation delimiting mechanism (90) configured to delimit rotation of the actuating members (31, 32) relative to each other in a direction about the rotation axis (R).

15. Depilating device (5) according to claim 14, wherein the rotation delimiting mechanism (90) comprises at least one of stop surfaces (95) at an actuating member (31, 32) and stop surfaces (96) at the connecting arrangement (50).

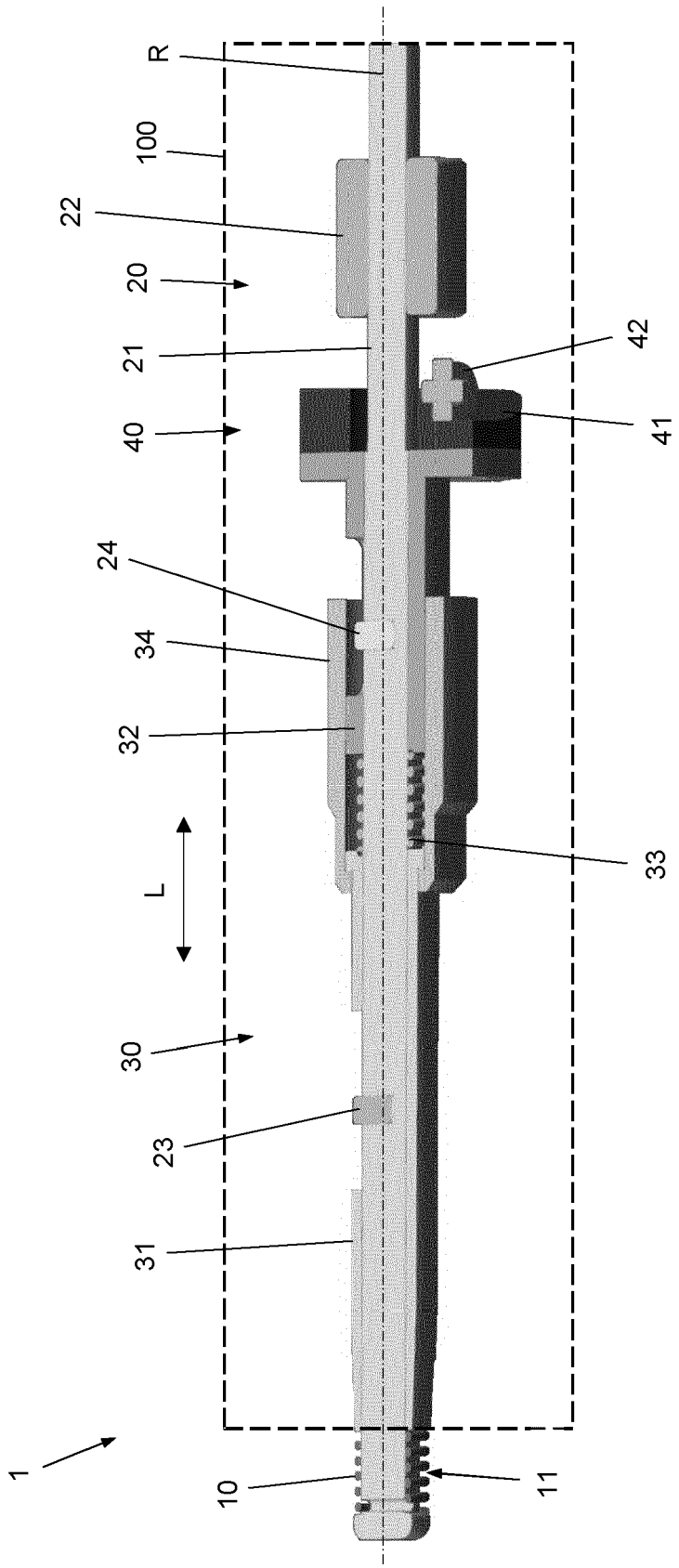


Fig. 1

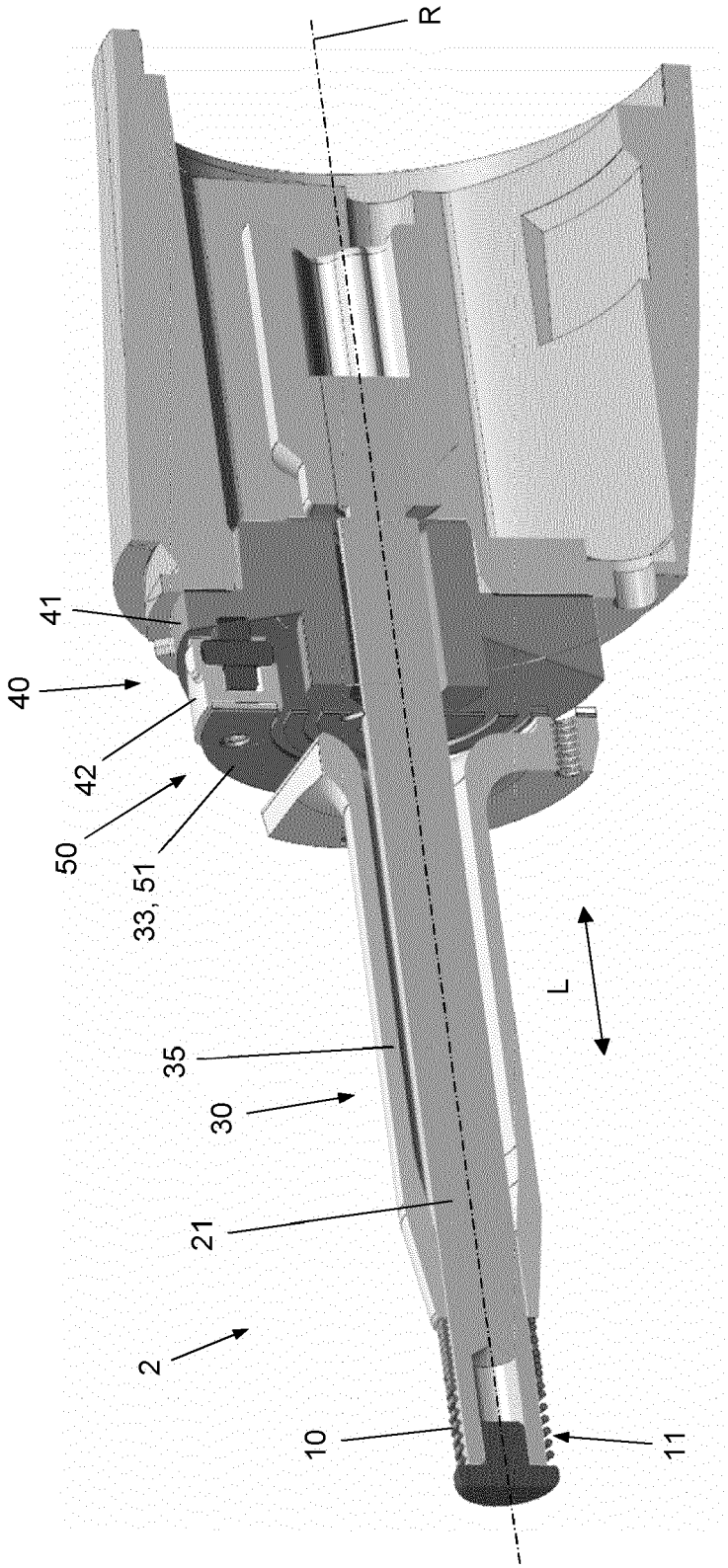
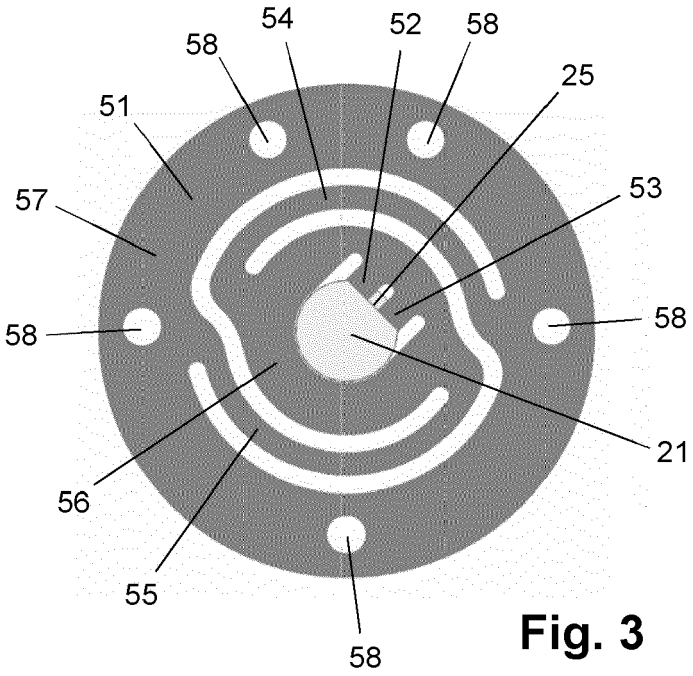


Fig. 2



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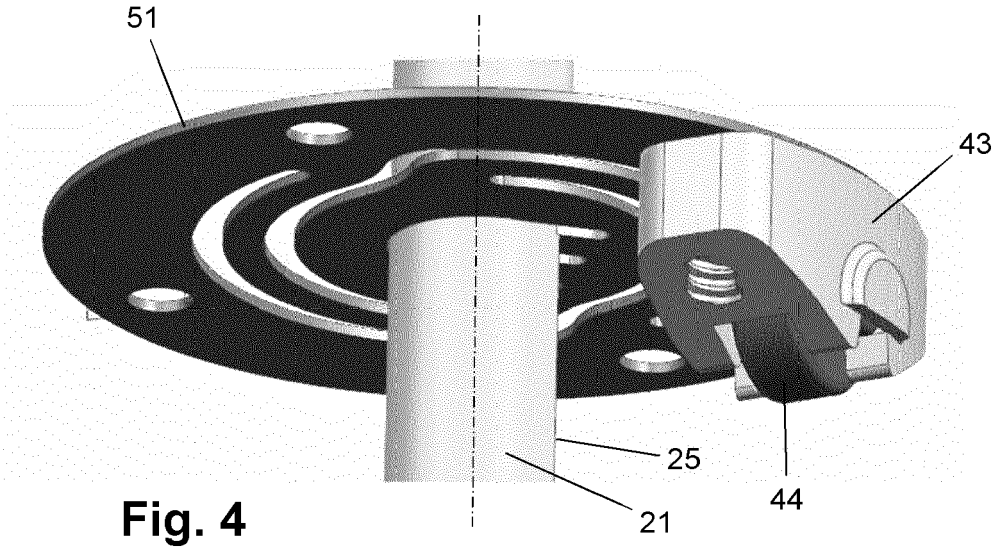

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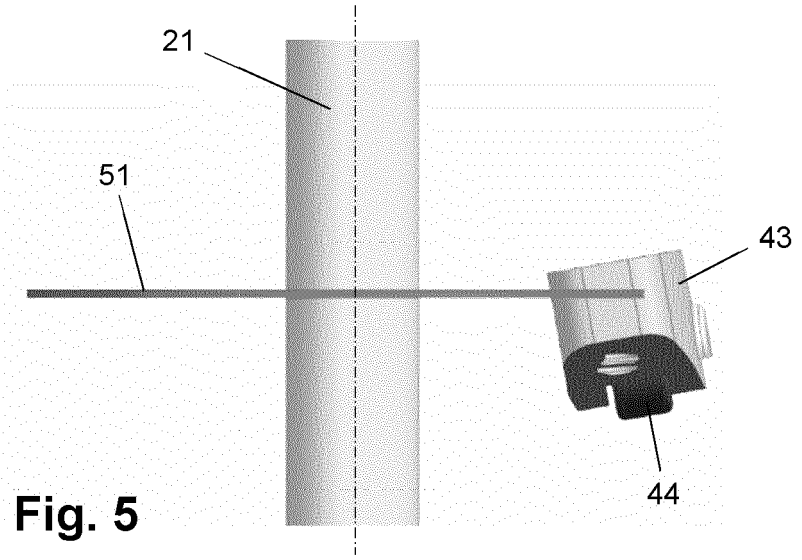

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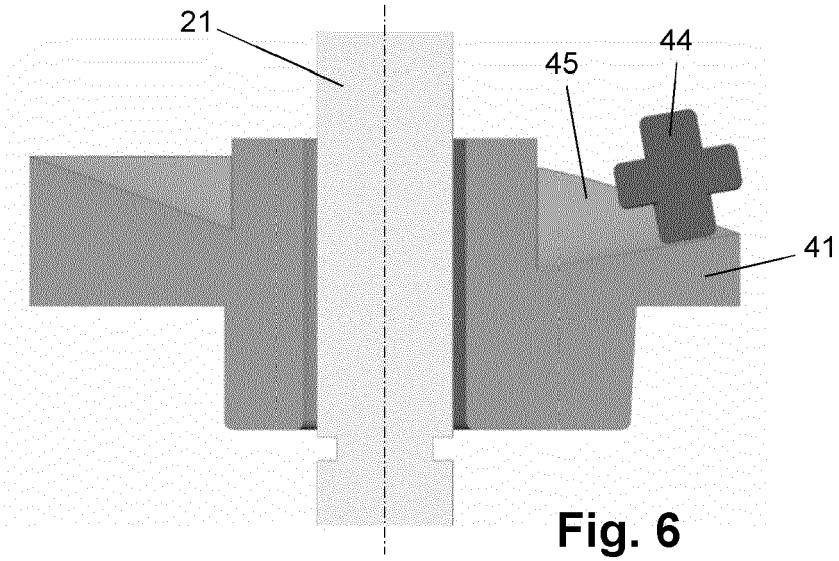

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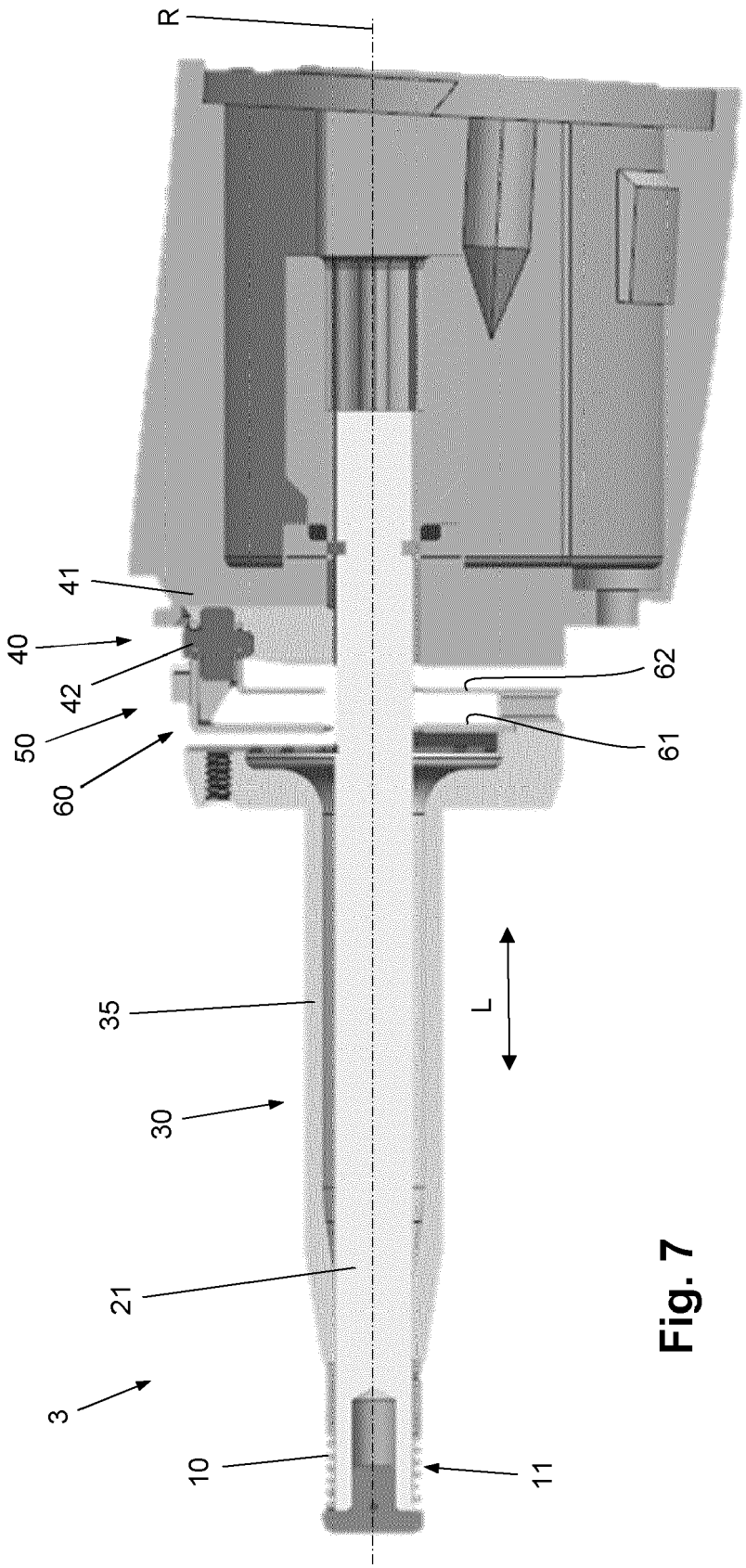

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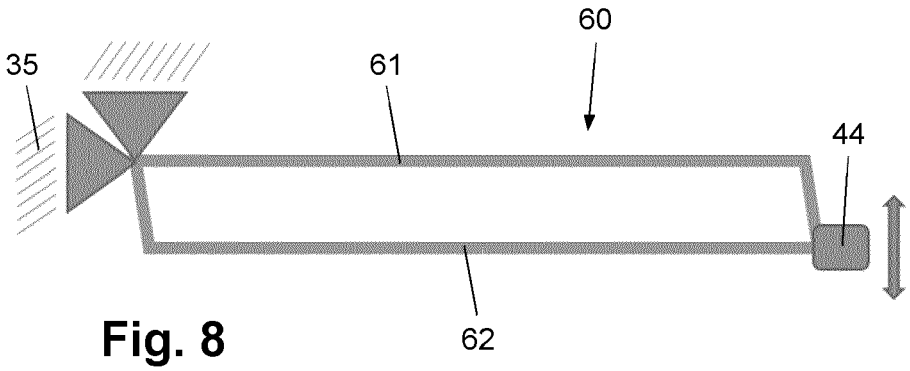

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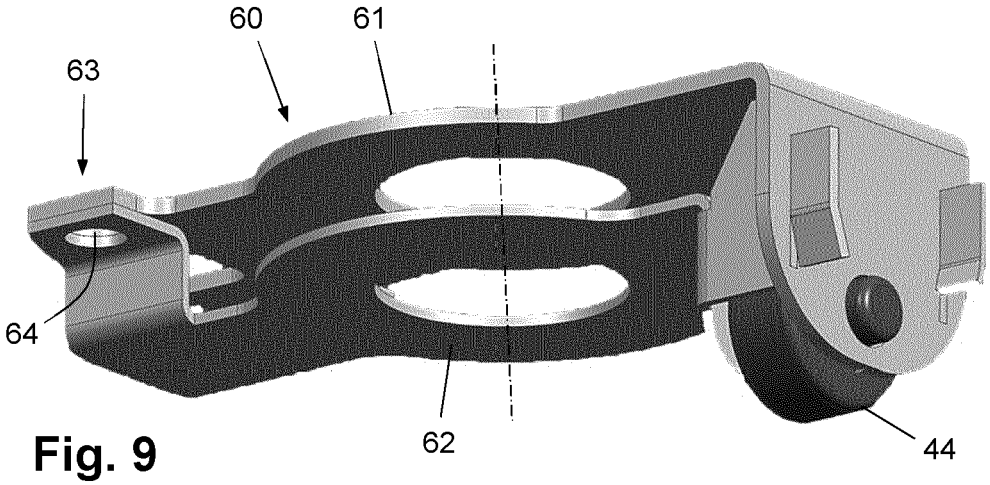

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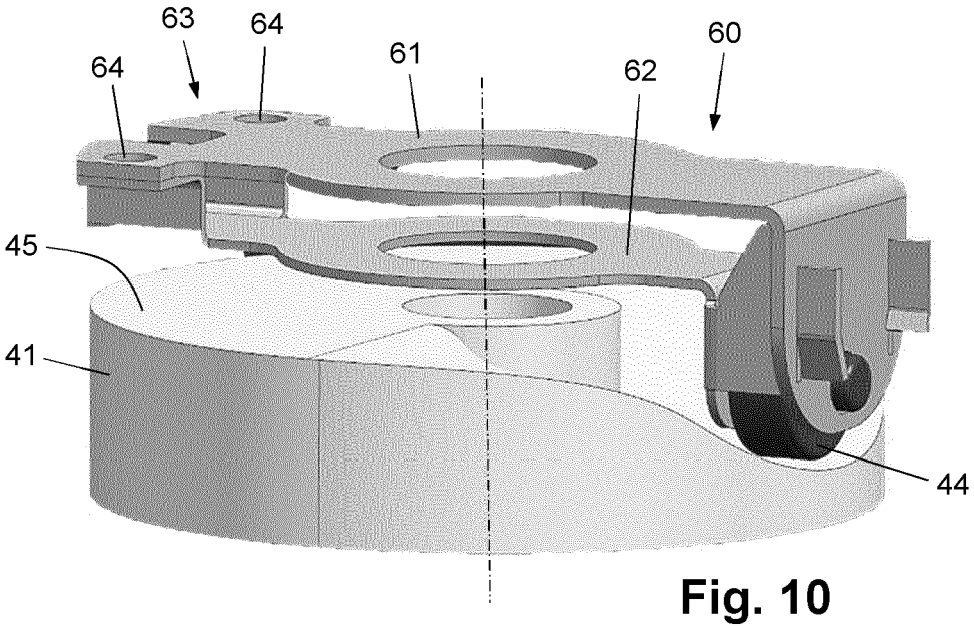

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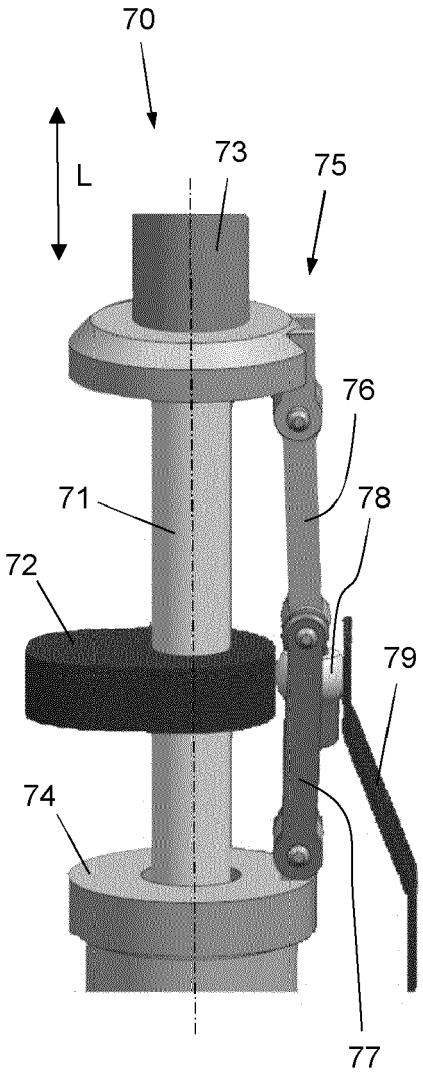

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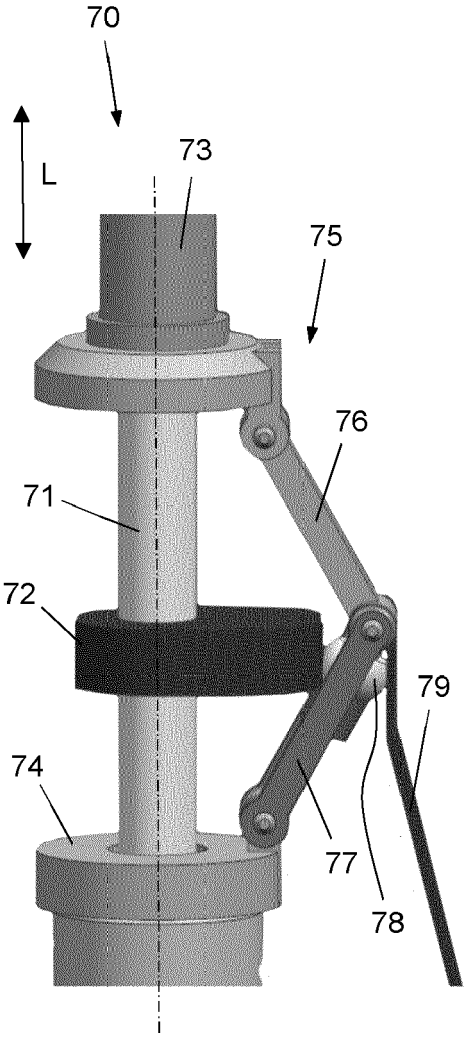

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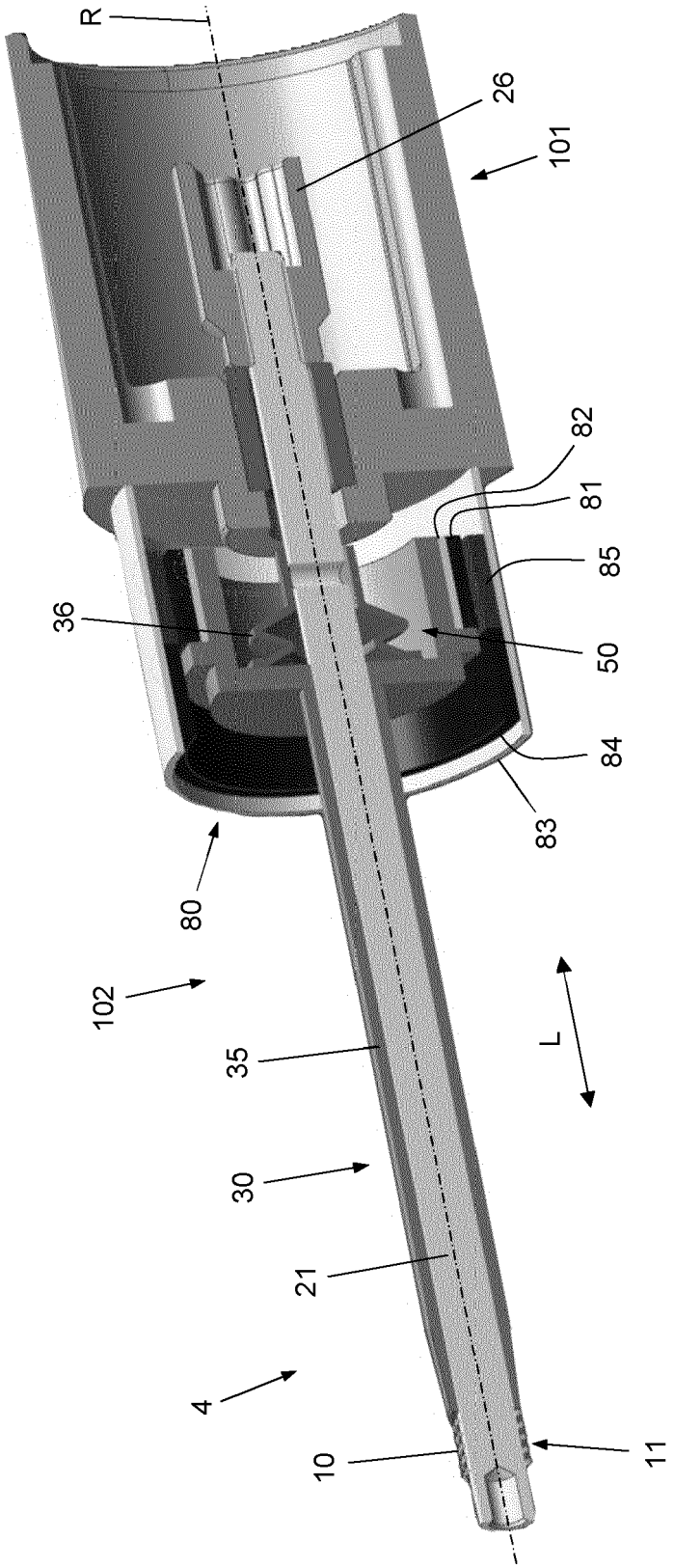
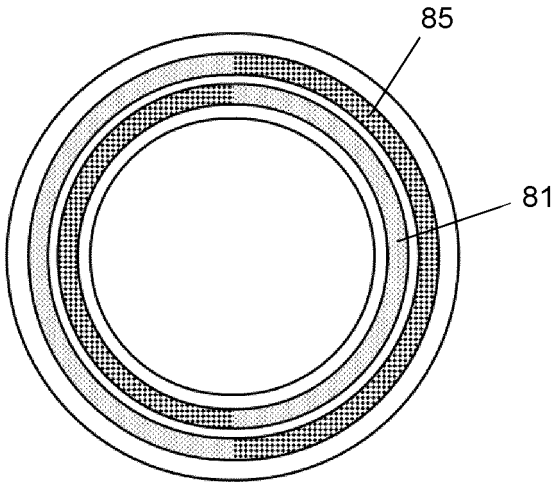
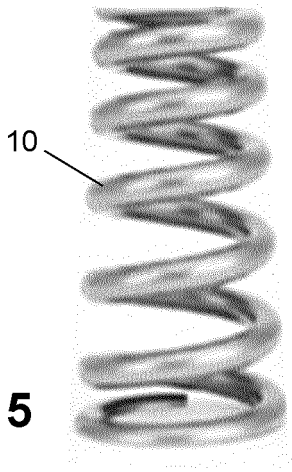


Fig. 13

Fig. 14





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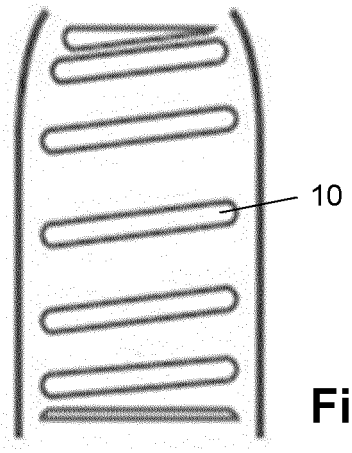

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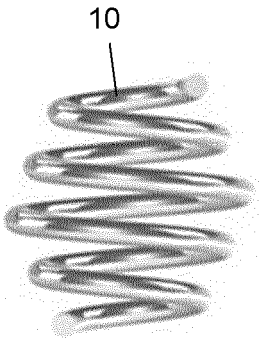

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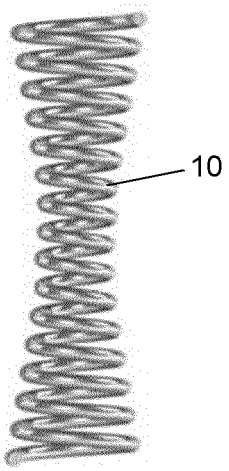

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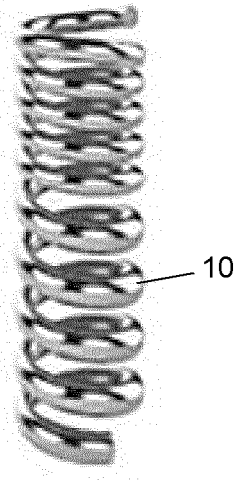

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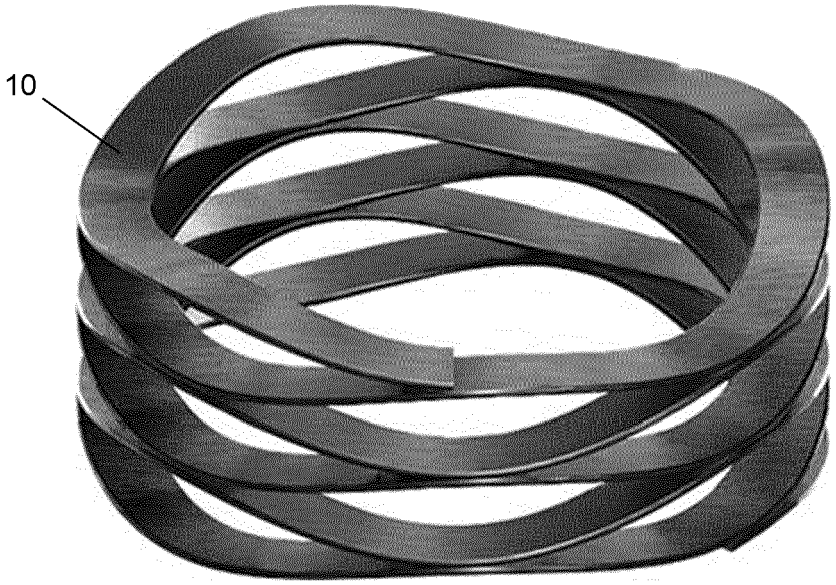

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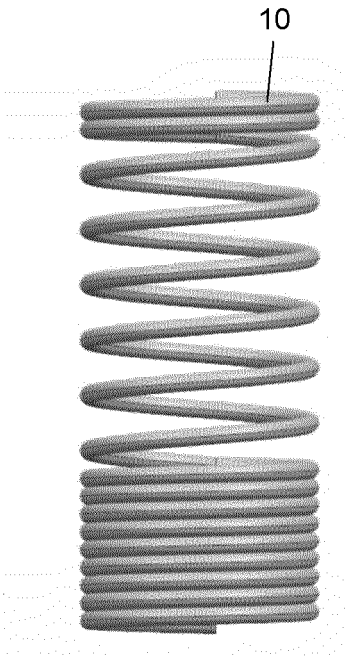

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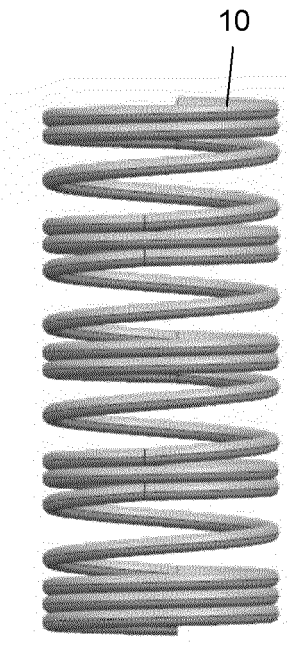

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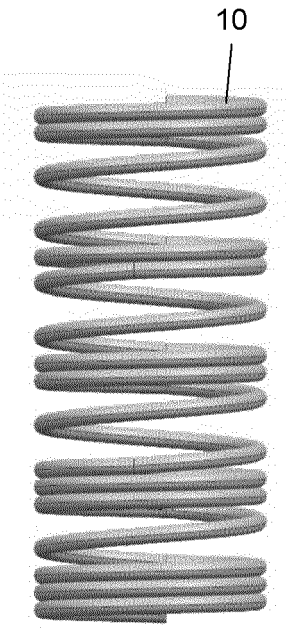

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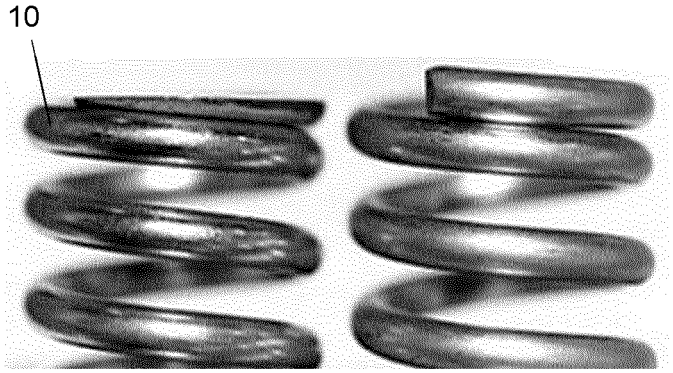

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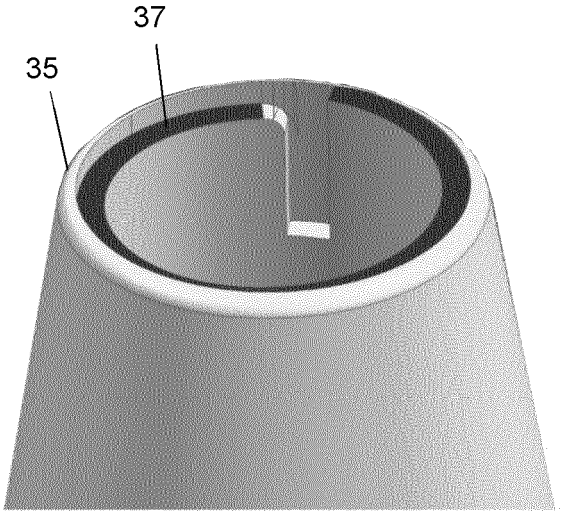

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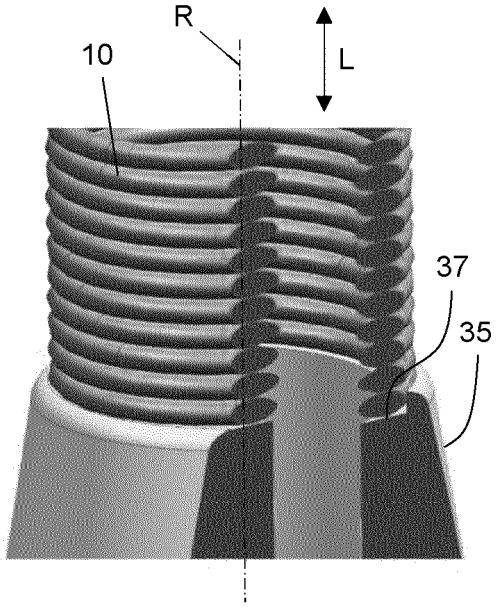

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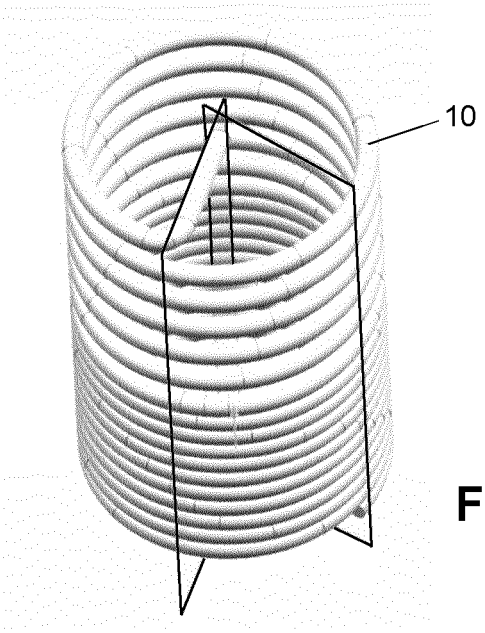

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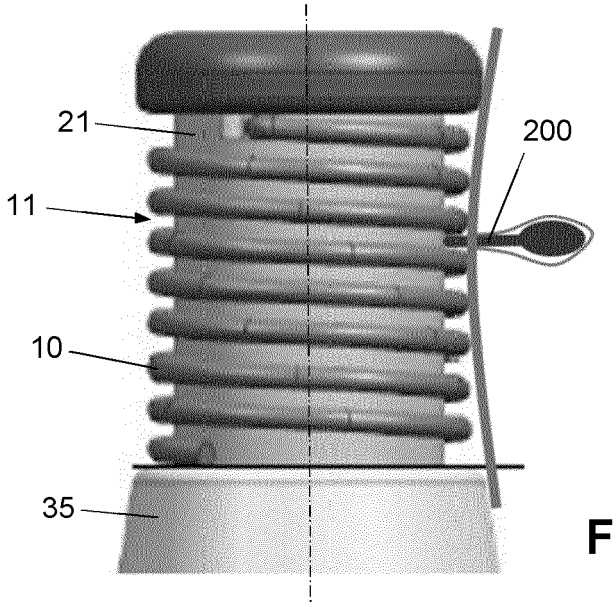

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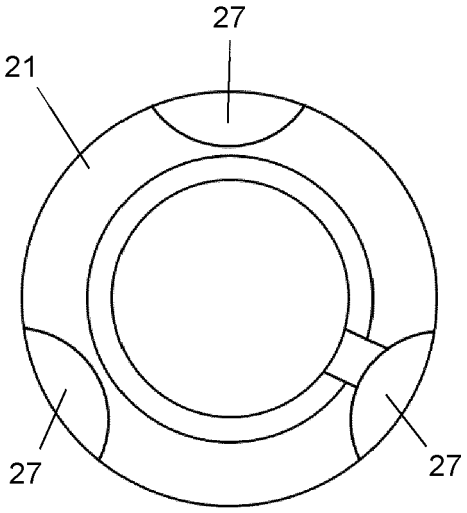

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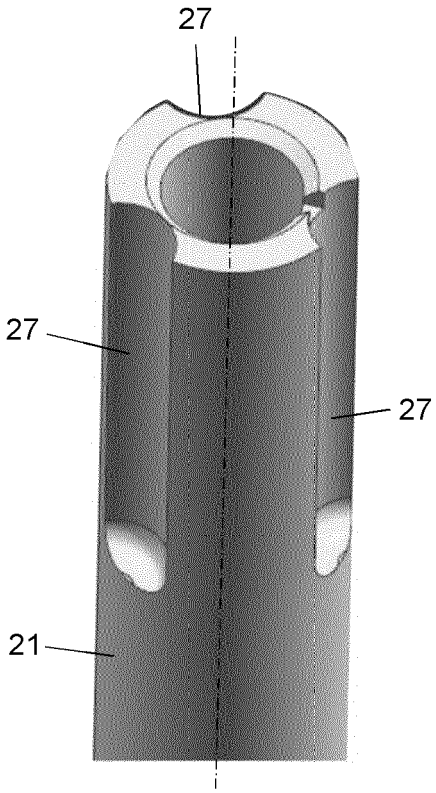

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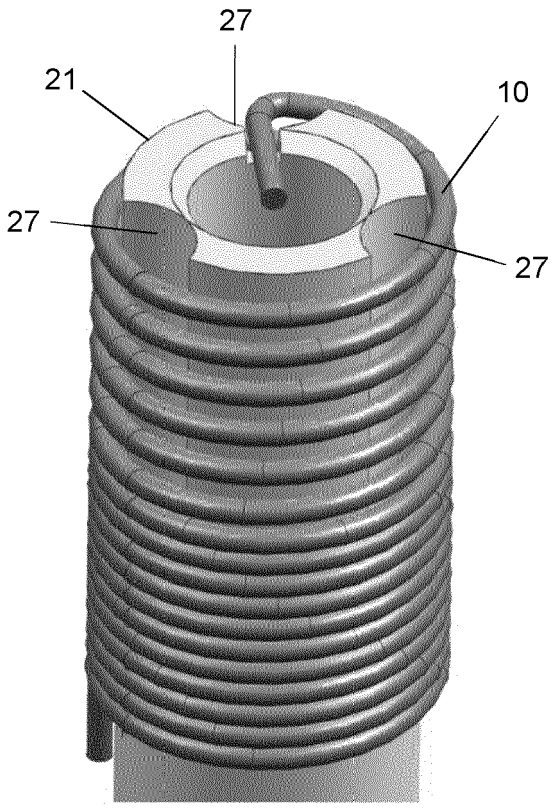

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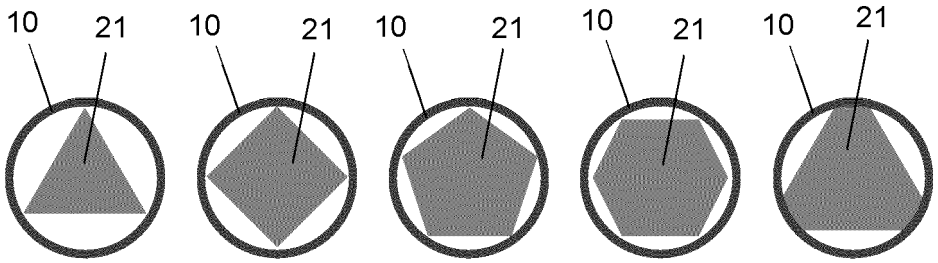

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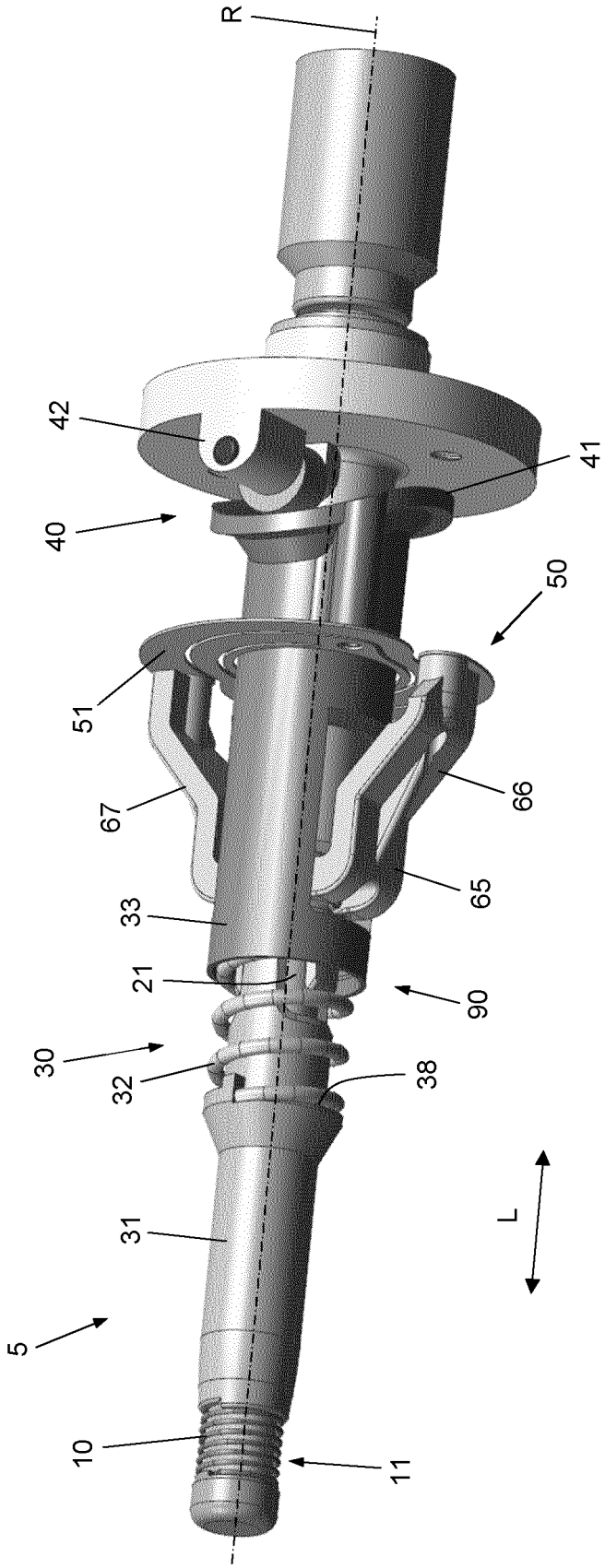

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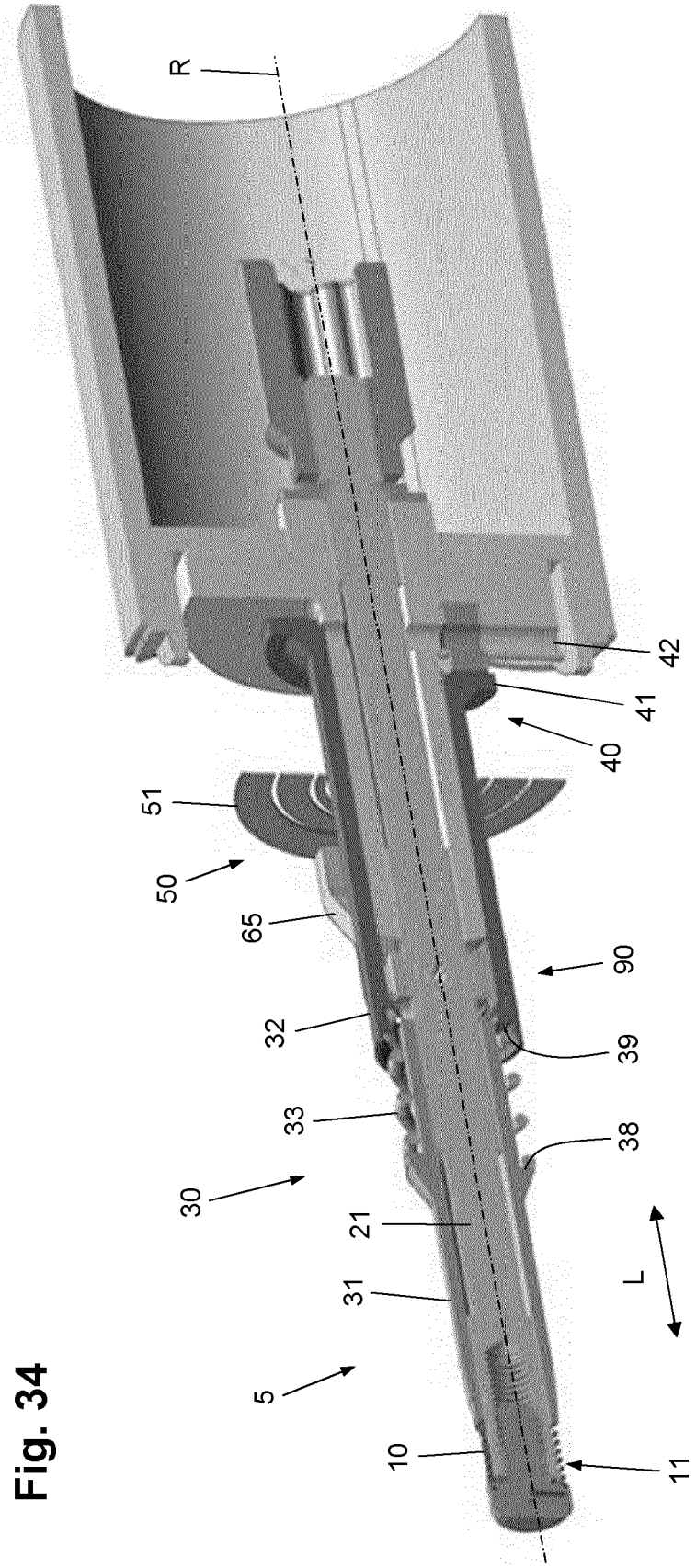

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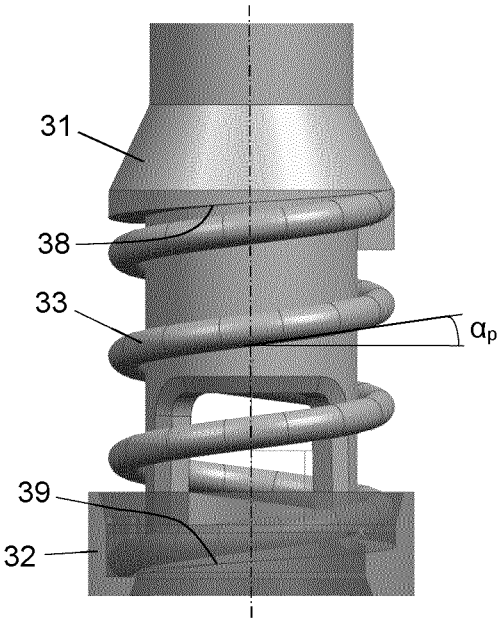

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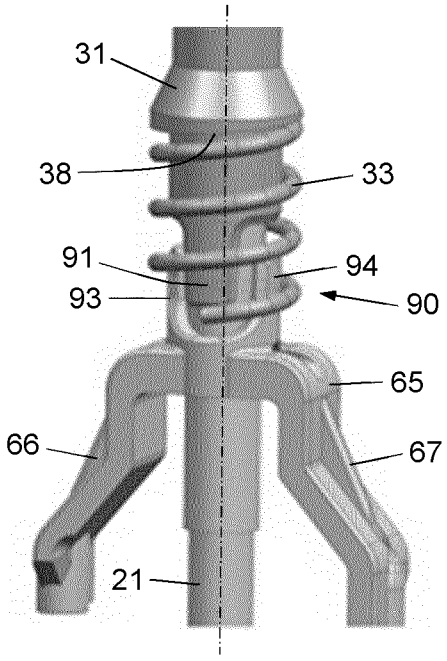

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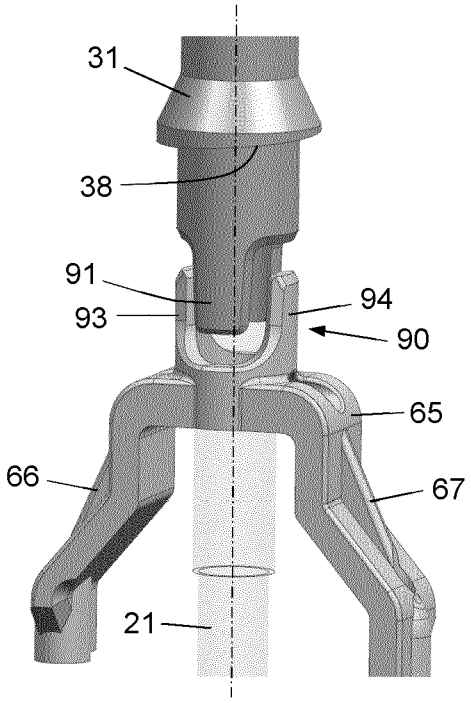

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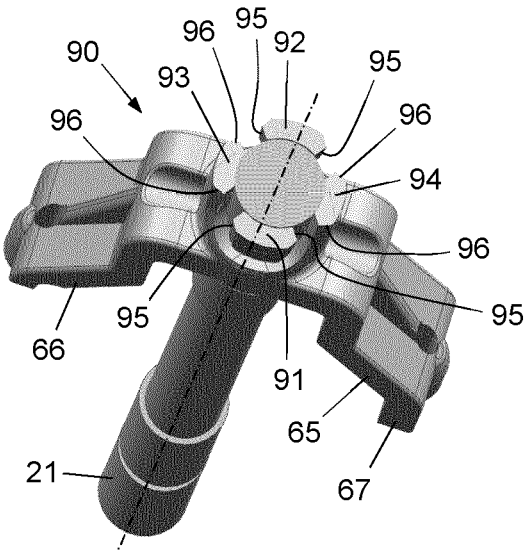

Fig. 38

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 1624

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 A	WO 94/14355 A1 (CAODURO GIANFRANCO [AR]) 7 July 1994 (1994-07-07) * the whole document *	1,2,7,9, 10 3-6,8, 11-15	INV. A45D26/00
A	EP 3 841 914 A1 (KONINKLIJKE PHILIPS NV [NL]) 30 June 2021 (2021-06-30) * the whole document *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

A45D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 May 2022	Frank, Lucia

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20-05-2022

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WO 9414355 A1	07-07-1994	AU 6043594 A	19-07-1994
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- WO 2021130385 A1 **[0002] [0003] [0004] [0014] [0026] [0027] [0041] [0043]**