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

(11) **EP 1 494 950 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
17.01.2007 Bulletin 2007/03

(21) Application number: **03721201.6**

(22) Date of filing: **14.04.2003**

(51) Int Cl.:
B65H 75/48 *(2006.01)*

(86) International application number:
PCT/SE2003/000605

(87) International publication number:
WO 2003/086930 (23.10.2003 Gazette 2003/43)

(54) **REELING DEVICE**

AUFWICKELVORRICHTUNG

DISPOSITIF D'ENROULEMENT

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR

(30) Priority: **15.04.2002 SE 0201132**
15.04.2002 SE 0201133

(43) Date of publication of application:
12.01.2005 Bulletin 2005/02

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EP 1 494 950 B1

Description

Field of the Invention

[0001] The present invention relates to the technical field of exhaust hose reeling devices, i.e. industrial reeling devices of the kind comprising an exhaust hose, a rotatably mounted drum for storing the exhaust hose, and at least one spring, preferably a coil spring, for winding the exhaust hose onto the drum.

Background Art

[0002] Reeling devices are used in the industry in working areas that are to be kept free from harmful exhaust gases. The reeling device is usually mounted in the ceiling or on a wall.

[0003] Reeling devices are for instance known from US 3,049,317, EP 0 968 952, US 3,822,719 and US 1,674,512.

[0004] US 3,049,317 disclose a spring loaded self compensating device having a flexible member and means to exert an opposing force upon extraction thereof from its housing to effect a rewinding of the member.

[0005] EP 0 968 952 disclose a retractable hose reel assembly comprising a reel rotatably mounted in a casing and a torsion spring for rotating the reel in a direction corresponding to winding of the hose on the reel.

[0006] US 3,822,719 disclose an apparatus for removing of gas and similar fluids from closed areas comprising a frame in which a drum is rotatably mounted. An outlet socket is set axially into one end of the drum in fixed relation to the frame and a hose is wound on the drum and has one end connected inside the drum to the outlet socket. A spiral spring device is mounted on a shaft fixed axially to the other end of the drum for rotating the drum to wind up the hose. Stop elements are provided on the hose and the frame to stop the winding of the drum and a releasable catch is secured to the frame and cooperates with tooth segments on the spring device to hold the drum in the desired position.

[0007] US 1,674,512 disclose a reel for supporting a tube for conveying air to the tires of an automobile and means for supplying the air from the pump to the reel and tube.

[0008] When needed for use, the user grasps a nozzle on the coiled exhaust hose and simply pulls out the required length of hose before connecting the nozzle to the exhaust pipe of the vehicle. As a result of the reeling-out operation, the reel spring, or springs, is tensióried. In the desired pulled-out position, the hose is prevented from being unintentionally wound in by means of a ratchet mechanism. After use, and after the nozzle has been disconnected, the user pulls the exhaust hose to release the ratchet mechanism and thereby allow the tensioned spring to drive the drum in the direction of winding in the hose.

[0009] Prior art further comprises motor-driven drums, in particular for heavy and/or long exhaust hoses. In this case, the drum is not controlled by means of the hose, but by means of a separate handheld control unit, which is connected to the motor drive by way of a cable or a remote control.

[0010] To handle the large, heavy-duty springs required to wind in heavy exhaust hoses, it is known to use separate spring cassettes for handling and mounting the springs. More particularly, each spring cassette can comprise a spring housing, a coil spring arranged in the spring housing, the outer end of which is attached to the housing, and an output or drive shaft, which is driven by the spring and connected to and rotated by the inner end of the spring. The spring cassette is mounted in such manner that the output shaft driven by the spring is concentric with and directly connected to the drum for driving it in the direction of winding in the hose.

[0011] To wind in heavy/long exhaust hoses, it is known to connect a plurality of such spring cassettes in parallel, and also to use spring cassettes which hold more than one spring.

[0012] One disadvantage of exhaust hose reeling devices according to prior art is that the spring/springs have to be dimensioned directly in dependence on the weight of the exhaust hose to be wound in. In heavy applications, it is not enough to use powerful and, thus, bulky springs to obtain the moment of force required to wind in the hose, and therefore more than one spring arranged in one or more cassettes is often needed. In particularly demanding applications, motor drive may be the only alternative.

[0013] Thus, exhaust hose reeling devices according to prior art have the disadvantage of requiring powerful springs and/or a plurality of cooperating springs to handle heavy exhaust hoses. This, in turn, results in a number of problems.

1. When a great moment of force is required for the winding-in operation, solutions involving spring drive are complicated, or even impossible, and sometimes motor drive is the only alternative.
2. Large, heavy-duty springs may be both difficult to handle and expensive, and the safety requirements are considerable.
3. Large, heavy-duty springs are disadvantageous from the point of view of construction, since large forces are exerted on the surrounding components, and special dimensions and design solutions are therefore needed. Prior-art racks for exhaust hose reeling devices are traditionally made of sheet iron to take up relatively high loads.
4. Using a plurality of springs/spring cassettes results in increased overall reel dimensions, which is undesirable from a practical as well as an aesthetic point of view.

Summary of the Invention

[0014] A general object of the present invention is therefore to provide an improved exhaust hose reeling device.

[0015] More particularly, it is an object to provide an exhaust hose reeling device involving one or more of the following improvements:

- reduction/elimination of the problems associated with the use of large/heavy-duty springs.
- reduction/elimination of the problems associated with the use of a plurality of springs/spring cassettes connected in parallel.
- simplified/cheaper construction and manufacture.
- a construction of lower weight.

[0016] According to a first aspect, an exhaust hose reeling device is provided, which in per se known manner comprises an exhaust hose, a rotatably mounted drum for winding in and reeling out the exhaust hose, and a shaft, called spring shaft, which is driven by at least one spring means adapted to wind in the exhaust hose and having an inner end and an outer end, the reeling device being characterised in that a downshift occurs, at least when the exhaust hose is wound in, which is such that the speed of the spring shaft relative to the outer end of the spring means is higher than the speed of the drum.

[0017] This first aspect is thus based on the idea of using a downshift transmission between the spring/springs and the drum in such manner that the speed of the drum, at least when the exhaust hose is wound in, is lower than the speed of the spring shaft relative to the outer end of the spring means.

[0018] One advantage of using a downshift transmission is that the moment of force exerted by the spring on the spring shaft does not have to be as great as in traditional direct drive constructions in order to drive the drum during the winding-in operation.

[0019] This, in turn, gives additional advantages related to design, function and operation.

[0020] One direct advantage is that the need for large springs/a plurality of springs can be essentially eliminated. At the same time, the downshift allows entirely new, advantageous manufacturing solutions and user functions, as will be described below.

[0021] One advantage is, thus, that the spring can be so dimensioned relative to the drum and the exhaust hose that, in an imaginary construction without said downshift and with a speed ratio of 1:1, it would not allow the whole hose to be wound in.

[0022] Accordingly, in a given application according to the first aspect, it is possible to use weaker springs, smaller springs and fewer springs. The stress on surrounding components is advantageously reduced, which makes overall constructional requirements less exacting and reduces the cost of manufacture.

[0023] One advantage of using smaller and weaker springs is generally simplified and safer maintenance and handling of the springs.

[0024] One particular advantage of reducing the stress on the surrounding components is that the exhaust hose reeling device can be designed without a big, heavy and bulky spring cassette for storing the spring and for absorbing the considerable spring forces. Thus, a reeling device according to this first aspect can be implemented using a considerably simpler spring cassette or - as will be described below - without the need for a separate spring cassette.

[0025] To achieve the speed-reducing downshift, the reeling device can comprise varying types of downshift transmission means. One embodiment of a reeling device according to the first aspect comprises a downshift gear transmission. Such a gear transmission can comprise at least one gear wheel or gear rim. In one embodiment, the spring shaft drives a small gear wheel, which in turn drives a gear rim, such as an internal gear rim, which is torsionally rigidly connected to the drum.

[0026] The gear rim can be mounted on the outside of an end wall of the drum, thus ensuring uniform driving of the drum. Arranging the gear rim on the drum end wall also saves space in the axial direction between the drum and the rack.

[0027] In one embodiment, the gear rim can be made in one piece with the drum end wall. Owing to this embodiment, even more reliable transmission between the gear rim and the drum end wall is obtained. In addition, the construction is simplified and, thus, the manufacture thereof made less complicated and less expensive.

[0028] In particular, the gear rim can be made in one piece with the drum end wall of a material comprising at least one of a polymer material and an aluminium material. Using any of these materials makes the reeling device lightweight and inexpensive, and improves the design options regarding the rack parts, for example in the case of injection moulding. The choice of material also affects the mounting of the reeling device, whose weight will be lower.

[0029] Other types of gear transmission can comprise additional transmission steps. A reeling device having one gear transmission can be made very compact, both axially and radially relative to the axis of rotation of the drum, while, at the same time, safe and reliable driving is obtained.

[0030] The downshift transmission can be supplemented with a means for setting the desired winding-in moment of force. If such a setting means is provided between the spring shaft and the downshift transmission, i.e. on the side of the transmission having the comparatively higher speed, the speed-downshift will allow for a finer setting "resolution" for the winding-in moment of force, i.e. it will be easier to balance the reeling device properly.

[0031] The spring means of the exhaust hose reeling device can consist of a coil spring. Coil spring here means a spring which is spirally wound and essentially flat in the

axial direction. When necessary, more springs, usually connected in parallel, can be used.

[0032] In one embodiment, the reeling device further comprises a rack arm which supports the drum, said rack arm having a space, called spring housing, for receiving the spring. By providing a spring housing in the rack arm itself, a reeling device that is easy to mount is obtained. Moreover, the simple design means reduced costs of mounting and manufacture. The spring housing can be completely or partially recessed in the rack arm, thus allowing the overall axial dimension of the reeling device to be reduced.

[0033] The rack arm can be made of a material comprising at least one of a polymer material and an aluminium material. Choosing such a material makes the rack arm less expensive to manufacture and reduces its weight.

[0034] The limiting walls of the spring housing can be formed in one piece with the rack arm using a material that comprises at least one of a polymer material and an aluminium material.

[0035] The spring shaft may be eccentrically arranged relative to the axis of rotation of the drum, which may advantageously reduce the axial dimension of the reeling device.

[0036] According to a second aspect, an exhaust hose reeling device is provided, comprising a rack arm, an exhaust hose, a drum which is rotatably mounted in the rack arm and adapted to wind in and reel out the exhaust hose, and a shaft, called spring shaft, which is driven by a spring for winding in the exhaust hose. This second aspect is characterised in that the rack arm comprises a spring housing for receiving said spring.

[0037] Accordingly, the second aspect is based on the idea of using a rack arm having an integrated spring housing, instead of using one or more separate spring cassettes. Although such a construction is particularly advantageous for use in combination with the downshift concept described above, this second aspect can be generally used also without downshift. Consequently, said second aspect can be implemented also in direct drive exhaust hose reeling devices.

[0038] In a particularly preferred embodiment of this second aspect, the spring housing is made in one piece with the rack arm. This can be achieved, for example, by the spring housing having an essentially cylindrical circumferential wall and an essentially circular bottom wall, said walls being made in one piece with the rest of the rack arm. The spring housing can also be integrated with the rack arm without being made in one piece therewith.

[0039] Preferably, the rack arm can be made by injection moulding of a polymer material or die-casting of an aluminium material.

[0040] The overall construction can be made very compact, particularly in the axial direction with reference to the axis of rotation of the drum. More particularly, the spring housing can be at least partially recessed in the rack arm.

[0041] According to a third aspect, an exhaust hose reeling device is provided, comprising an exhaust hose, a rotatably mounted drum for winding in and reeling out the exhaust hose, and a shaft, called spring shaft, which is driven by a spring for winding in the exhaust hose. This third aspect is characterised in that the spring shaft is eccentrically arranged relative to the axis of rotation of the drum. This aspect also allows designing of an exhaust hose reeling device of small axial dimensions. It can be implemented without the use of a downshift transmission.

[0042] According to a fourth aspect, an exhaust hose reeling device is provided, comprising an exhaust hose, a rotatably mounted drum for winding in and reeling out the exhaust hose, and a shaft, called spring shaft, which is driven by a coil spring for winding in the exhaust hose. This fourth aspect is characterised in that the spring shaft is eccentrically arranged relative to the coil spring.

[0043] Eccentrically arranged here refers to the relationship between the spring shaft and an imaginary centre of the essentially circular outer circumference of the spring.

[0044] Such a construction can be generally used for mounting coil springs for reeling devices, including devices without downshift and without integrated spring housings.

[0045] The advantage of such a construction is that the turns of the spring are effectively separated from each other, which facilitates the relative motion of the turns and results in less friction and better overall performance of the spring. This aspect can be used to reduce the spring dimensions.

[0046] According to a fifth aspect, an exhaust hose reeling device is provided, comprising a rack arm, an exhaust hose, a drum which is rotatably mounted in the rack arm for winding in and reeling out the exhaust hose, and a spring for winding in the exhaust hose. This fifth aspect is characterised in that the rack arm is made of a material comprising at least one of a polymer material and an aluminium material. Accordingly, such a rack arm can be made by injection moulding of a polymer material or die-casting of an aluminium material. This aspect can be used not only in combination with downshift and integrated spring housings, but also in conventional direct drive exhaust hose reeling devices with separate spring cassettes.

[0047] According to a sixth aspect, a method of manufacturing an exhaust hose reeling device of the kind comprising a rack arm, an exhaust hose, a drum which is rotatably mounted in the rack arm for winding in and reeling out the exhaust hose, and a coil spring for winding in the exhaust hose. The method is characterised by the steps of forming said rack arm in one piece with a spring housing, mounting a continuous drive shaft in a bottom wall of the spring housing, and applying the coil spring in the spring housing, in connection with which an inner end of the coil spring is connected to said drive shaft.

[0048] According to a seventh aspect, an exhaust hose reeling device is provided, comprising an exhaust hose,

a rotatably mounted drum for winding in and reeling out the exhaust hose, spring means for driving the drum in the winding-in direction, and ratchet means for preventing the exhaust hose from being unintentionally wound in when it is in a pulled-out state and the spring means is tensioned, which spring means comprises a ratchet rim, which rotates with the drum and has a plurality of ratchet teeth distributed along its circumference. The reeling device according to the seventh aspect is characterised by a gear rim, which is driven by the spring means and rotates with the drum for driving thereof and which is located at least partially in the same radial plane as the ratchet rim.

[0049] One particular advantage of a reeling device according to this aspect is that, owing to the fact that the driving gear rim and the ratchet teeth are arranged at least partially in a common radial plane, it can have small axial dimensions with reference to the axis of rotation of the drum.

[0050] A further advantage is that the location of the gear rim and the ratchet rim allows them to be made in one piece with one another and/or in one piece with an end wall of the drum. This in turn gives considerable advantages in terms of both reliability in operation and manufacturing costs.

[0051] According to this aspect, the gear rim can preferably have the form of an internal gear rim with gear teeth that are turned radially inward and can further be located radially inside the ratchet rim.

[0052] The common radial plane can preferably be located between the drum and a rack arm of the reeling device which supports the drum.

[0053] According to the seventh aspect, the gear rim and the ratchet rim can be made in one piece with one another. In particular, they can be made in one piece with an end wall of the drum. This allows efficient manufacture and effective protection against the hose being unintentionally wound in.

[0054] Said end wall, the ratchet rim and the gear rim can be made in one piece, preferably by injection moulding, of a polymer material. They can also be made in one piece, preferably by die-casting, of an aluminium material.

[0055] Said end piece can be made in one piece with a shaft journal for rotatable mounting of the drum.

[0056] In one embodiment according to this aspect, the reeling device can further comprise a plurality of axially open locking compartments, which are distributed along the circumference, said locking compartments being arranged radially between the ratchet rim and the gear rim and adapted to receive a locking pin for temporarily locking the drum to prevent it from rotating. Such locking compartments can be limited along the circumference by essentially radially extending wall elements made in one piece with the ratchet rim and the gear rim.

[0057] In a particularly preferred embodiment according to this aspect, the exhaust hose reeling device has a speed-downshift transmission.

[0058] In one embodiment of the seventh aspect, the spring means can comprise at least one coil spring.

[0059] It will be appreciated that the aspects described above can be combined in a number of ways and that the aspects can be used independently of each other to obtain the above-mentioned and other advantages.

Brief Description of the Drawings

[0060] The invention will now be described in more detail by means of a non-limiting embodiment and with reference to the accompanying drawings.

[0061] Fig. 1 is a perspective view of an embodiment of an exhaust hose reeling device.

[0062] Fig. 2 is an exploded view of part of the reeling device in Fig. 1.

[0063] Fig. 3 is a perspective view of parts of an evacuation side of the reeling device in Fig. 1.

[0064] Fig. 4 is a perspective front view of a rack arm of the reeling device in Fig. 1.

[0065] Fig. 5 is a cross-sectional view of the rack arm in Fig. 4.

[0066] Fig. 6 is a perspective view of an outer side of the rack arm in Fig. 4 with drive means mounted therein.

[0067] Fig. 7 is a perspective view of an inner side of the rack arm in Fig. 4 with a gear drive mounted therein.

[0068] Fig. 8 is a cross-sectional view of the rack arm shown in Fig. 6 and Fig. 7.

[0069] Fig. 9 illustrates a combined setting and releasing device.

[0070] Fig. 10 is a perspective view of a drum end wall of the reeling device in Fig. 1 and also shows, in enlarged scale, parts of a gear rim and a ratchet rim.

[0071] Fig. 11 is a cross-sectional view of the drum end wall in Fig. 10.

[0072] Fig. 12 shows the drum end wall in Fig. 8 in engagement with the gear wheel driven by the spring.

[0073] Figs 13-15 illustrate the different operating positions of a ratchet mechanism.

[0074] Fig. 16 is a plan view of an embodiment of a drum end wall with an integrated spring housing.

Description of a preferred embodiment

[0075] In Figs 1-3, reference numeral 1 generally designates an exhaust hose reeling device for winding in an exhaust hose 2, which is indicated schematically by a dashed line in Fig. 1 and which is designed for extraction of exhaust gases from the tail pipe of a vehicle. For this purpose, the reeling device 1 is adapted to be connected to a suction device (not shown).

[0076] The exhaust hose reeling device 1 comprises as its main components - besides the exhaust hose 2 - a rack 3, a drum 5 which is rotatably mounted in the rack 3 and drive means for driving the drum 5 at least in one winding-in direction B.

[0077] The rack 3 is essentially U-shaped and comprises two mounting sections 7 for suspending the rack

3 from the ceiling or mounting it on a wall, and two rack arms which project from the mounting sections 7 and support the drum 5 between them. The rack arm on the driving side of the reeling device 1 (Figs 1 and 2) comprises two sections 11 and a supporting unit 13 mounted thereon. The rack arm on the evacuation side of the reeling device 1 (Fig. 3) also comprises two sections 15 and a supporting unit 17 mounted thereon. In the example shown, the sections 7, 11 and 15 are made of metal and welded together to form a U, as illustrated in the figure, while the supporting units 13 and 17 are made of a polymer material, such as an injection-moulded polymer material. The supporting units 13 and 17 can be made, for example, of polyamide, polypropylene, polyester or any other suitable structural plastic. Reference numeral 9 designates fittings for mounting the rack 3.

[0078] The supporting units 13 and 17 are each provided with two elongate spaces 19 for receiving the sections 11 and 15, respectively, and mounting holes 21 corresponding to mounting holes 23 in the sections 11/15.

[0079] The supporting unit 13 on the drive side of the reeling device will now be described in more detail with reference to Figs 4-8. The main functions of the supporting unit 13 are to support the drum together with the other unit 17 and to support parts of the driving device, as will be described below.

[0080] The unit 13 has a spring-receiving space 31, called spring housing, which is open on the side oriented toward the outer side of the unit 13 (i.e. the side facing away from the drum 5) for receiving at least one coil spring 41. The spring housing 31 is defined by an essentially cylindrical, circumferential wall 33 and a bottom wall 35, which are both made in one piece with the rest of the unit 13. In the embodiment shown, the spring housing 31 is thus both integrated with the unit 13 and recessed therein.

[0081] The exploded view in Fig. 2 shows the coil spring 41 before mounting, while Fig. 6 and Fig. 8 show the coil spring 41 in the mounted state in the spring housing 31. The construction is such that the coil spring 41 is tensioned when the exhaust hose is pulled out from the drum 5 in the reeling-out direction A, so that the coil spring 41 can drive the drum 5 in the winding-in direction B allowing the hose 2 to be wound onto the drum 5.

[0082] The spring housing 31 is provided with means which engages the outer end 43 of the spring 41 to form an abutment when the spring 41 is tensioned. In the embodiment shown, said engagement means is a specially designed recess 45 in the circumferential wall 33 of the spring housing 31. The recess 45 has opposite undercut edges 47, and the outer end 43 of the coil spring 41 is shaped in such manner that it engages one of said edges 47, depending on the orientation of the mounted spring. Thus, this design is advantageous since it allows easy mounting 41 of the spring in an optional position depending on the desired winding-in direction of the drum 5, while the engagement as such is easily achieved by inserting the spring 41 in the spring housing 31.

[0083] The bottom wall 35 of the spring housing 31 is provided with a through opening 51 (Fig. 4) intended for a shaft 53, called spring shaft, which is driven by the spring 41 and which has an inner end 54 that is located in the spring housing 31 and an outer end 56 that is located on the inner side of the supporting unit 13, as shown in Fig. 8. The spring shaft 53 is rotatably mounted in the opening 51 by means of a ball bearing 62 fitted in the opening 51 (Figs 2 and 8). The inner end 54 of the spring shaft 53 has a radial engagement edge 55, as shown in Fig. 6, for engaging the inner end of the spring 41. Reference numeral 57 designates a hexagonal hole for manually adjusting the winding-in moment of force, as will be described in more detail below.

[0084] The outer end 56 of the spring shaft 53 is drivingly connected to a gear wheel 59. In the embodiment shown, the gear wheel 59 is concentrically mounted on the spring shaft 53. Moreover, in this embodiment, the gear wheel 59 is operatingly connected to the spring shaft 53 by means of a special setting and releasing device, generally designated 61, the function of which will be described below. The device 61, which is shown in detail in Fig. 9, comprises a locking pin 63 which is provided with a bevelled outer end and which is radially displaceable back and forth in the outer end 56 of the spring shaft 53. The locking pin 63 engages in one of three corresponding bevelled locking grooves 65 of the gear wheel 59. A resilient means 64, such as a rubber element, exerts a radially outward force on the locking pin 63. The device 61 is covered by a lid 60, as shown in Fig. 7.

[0085] During normal operation (winding in/reeling out), the locking pin 63 engages in one of the three locking grooves 65, as shown in Fig. 9, the device 61 acting as a torsionally rigid or fixed connection, which prevents any undesired relative rotation between the spring shaft 53 and the gear wheel 59. More specifically, when the hose is reeled out and the gear wheel 53 thus driven in direction A, a force is exerted on the locking pin 63 by the radial edge designated 67 in Fig. 9 for transmitting a spring-tensioning moment of force to the spring shaft 53. On the other hand, when the exhaust hose 2 is to be wound in, the spring 41 drives the spring shaft 53 in direction B in Fig. 8, the locking pin 63 transmitting the driving torque to the gear wheel 59 through the edge 67.

[0086] As indicated at E2 in Fig. 5, the opening 51 for the spring shaft 53 is eccentrically arranged relative to the spring housing 31 (i.e. relative to the essentially circular outer circumference of the spring 41), the dashed line L1 in Fig. 5 representing the symmetry axis of the cylindrical spring housing 31 and the dash and dot line L2 representing the axis of rotation of the spring shaft 53. This offset E2 creates "asymmetry" in the turns of the spring, which effectively prevents adjoining turns of the coil spring 41 from interlocking in an undesired manner due to friction and/or adhesion. This allows a more efficient and balanced operation of the spring 41. In a simpler variant, the axes L1 and L2 may coincide.

[0087] As shown in Fig. 6 and also in the exploded view in Fig. 2, the spring 41 is mounted in the spring housing 31, and then a circular plate 66 having a centre hole that corresponds to the inner end 54 of the spring shaft 53 is placed over the innermost turns of the spring. The spring 41 is then secured to the spring housing 31 by means of a locking element 68, and, eventually, a lid 72 is screwed onto the unit 13 to cover the spring housing 31. Reference numeral 74 designates four grooves that are formed in the circumferential wall 33 and the bottom wall 35 of the spring housing 31 for facilitating removal of the spring 41. To remove the spring 41, any suitable flexible means can be inserted through each such groove 74 and passed round the outermost turns of the spring to allow the spring 41 to be taken out.

[0088] The drum 5 and the driving thereof will be described in more detail below with reference to Figs 1-3 and Figs 10-12.

[0089] The drum 5 comprises two opposite end walls 71, 73, which are mounted in the supporting units 13 and 17, respectively, of the rack 3. The drum 5 further comprises a tubular means 75, which connects the end walls 71, 73 with one another. In the embodiment shown, the tubular means 75 is made of a metal sheet that is bent to a cylindrical shape and attached by screwing to the inside of the end walls 71, 73.

[0090] Preferably, the drum 5 is intended for winding the exhaust hose 2 onto the tubular means 75 and unwinding it therefrom in only one hose layer, as opposed to smaller and lighter reeling devices, for example, for supply cables, such as electric cables and compressed-air hoses, which are wound in several layers.

[0091] One end of the exhaust hose 2 is connected to a pipe socket 79 (Fig. 3), which is connected to a central opening 80 in the drum end wall 73. The opening 80 is in turn rotatably connected to a non-rotating pipe-coupling 83 formed in the supporting rack unit 17 and adapted to be connected to a suction device (not shown).

[0092] In the embodiment shown, driving of the drum 5 is effected on the drum end wall 71 supported by the supporting rack unit 13. The supporting unit 12 has an opening 81 in which a ball bearing 83 is provided for rotatably carrying a shaft journal 85 of the drum end wall 71. In the embodiment shown, the drum end wall 71 - like the supporting units 13 and 17 - is made in one piece of, for example, an injection-moulded polymer material, thus allowing the shaft journal 85 to be made in one piece with the drum end wall 71. In general, the same material options are available for the integrally formed drum end walls 71 and 73 as for the integrally formed rack units 13 and 17.

[0093] The drum end wall 71 is made in one piece with a ratchet rim 91, which has a plurality of external, inclined ratchet teeth as well as two "free" portions 92 without such ratchet teeth. The drum end wall 71 is further made in one piece with an internal gear rim 93, which in this embodiment is arranged radially inside the ratchet rim 91.

[0094] The function of the ratchet rim 91 is to prevent, in per se known manner, the hose 2 from being unintentionally wound in (direction B) when it is in use and pulled out to varying degrees.

[0095] In the locked position according to Fig. 13, a ratchet pawl 94 engages the ratchet teeth of the ratchet rim 91 in such manner that the drum 5 is prevented from rotating in the reeling-out direction B, but allowed to rotate in the winding-in direction A as the ratchet pawl 94 moves over the ratchet teeth.

[0096] To release the ratchet mechanism, the user pulls out the hose 2 far enough in the reeling-out direction A for the ratchet pawl 94 to reach one of the free portions 92, as shown in Fig. 14. The hose 2 is then released and the tensioned spring 41 can drive the drum 5 in the winding-in direction B according to Fig. 15.

[0097] The internal gear rim 93, which is made in one piece with the drum end wall 71 and, thus, torsionally rigidly connected to the drum 5, engages the gear wheel 59, as shown schematically in Fig. 12. The gear wheel 59 connected to the spring shaft 53 and the internal gear rim 93 of the drum end wall 71 together form a downshift transmission. Unlike prior-art direct drive reeling devices, the axis of rotation L2 of the spring shaft 53 is eccentric relative to the axis of rotation L3 of the drum 5, as indicated by E2 in Fig. 5.

[0098] Owing to the downshift transmission, the speed of the spring shaft 53 is higher than the speed of the drum 5 and the driving torque of the spring shaft 53 is correspondingly upshifted during winding-in. In the embodiment shown, the gear ratio is about 5:1, but it can be varied significantly. Thus, gear ratios ranging from, for example, 2:1 to 10:1 are conceivable.

[0099] As described above, the downshift transmission gives several advantages in applications which traditionally would require heavy-duty coil springs and, in many cases, the use of more than one such spring.

[0100] By using a speed-downshift transmission between the spring shaft 53 and the drum 5, the required winding-in moment of force can be obtained using considerably smaller and lighter springs than was previously possible and, in most applications, one coil spring will be enough, even for relatively heavy/long hoses. Accordingly, the spring 41 can be dimensioned in such manner that, in an imaginary construction without downshift and a speed ratio of 1:1, it would not allow the whole exhaust hose to be wound in.

[0101] Using smaller and weaker springs is advantageous in several ways in terms of manufacturing costs, handling safety and choice of material for the surrounding structures. In particular, the use of weaker springs allows weaker, and thus less expensive, constructions in the spring housing/spring cassette. Thus, integration of the spring housing in the supporting unit 13 is considerably facilitated, while at the same time the whole unit can be made of a weaker material, such as a polymer material, than traditional sheet-metal constructions.

[0102] As a non-limiting example, which illustrates the effect of the downshift transmission, it may be noted that

the applicant behind the present invention has marketed exhaust hose reeling devices having three springs arranged in two spring cassettes connected in parallel, each coil spring, in the tensioned state, having the ability to exert a torque of about 25 Nm, which gives a total torque of about 75 Nm. Tests have shown that a speed ratio of about 1:5 for the downshift transmission allows said three coil springs of 25 Nm to be reduced to only one smaller coil spring of about 15 Nm and the spring thickness to be reduced from 1.5 mm to 1.1 mm.

[0103] The possibility of using weaker springs is not the only advantage of the downshift transmission. It also allows a considerably improved and more accurate setting of the winding-in moment of force than without downshift. In prior-art exhaust hose reeling devices, the winding-in moment of force is traditionally changed by changing the number of complete hose windings on the drum.

[0104] In the present example, the winding-in moment of force acting on the drum 5 can be set using the setting device shown in Fig. 9. For instance, to slightly increase the winding-in moment of force on the drum 5 for the purpose of balancing the reeling device 1, the spring shaft 53 is rotated by means of a tool (not shown) which is inserted in the hexagonal hole 57 in the shaft end 54 (Fig. 6). To this end, the lid 72 is formed with an access hole 74 (Fig. 1).

[0105] If the drum 5 is kept in the locked position (see below), the gear wheel 59 being thus also locked, the spring shaft 53 can be rotated in the direction of the arrow A in Fig. 9. The locking pin 63 will then be pushed out of its engagement position and move towards the next locking groove 65 while the spring 41 is being tensioned. It will be appreciated that with a gear ratio of 5:1 and with three locking grooves 65, the setting resolution for the moment of force is 5 * 3 = 15 times finer than in prior-art solutions, i.e. it takes 15 "clicks" of the setting device to increase the winding-in moment of force so that it corresponds to one complete hose winding.

[0106] It should be noted that the device shown in Fig. 9 does not serve exclusively as a setting device. It also protects the spring 41 in the event that someone manually rotates the drum 5 in the winding-in direction when the exhaust hose 2 is completely wound in. In this situation, the gear rim 93 will drive the gear wheel 59 in the direction of the arrow B in Fig. 9. The locking pin 63 will then be pushed out of the locking groove 65, thereby preventing undesired backward turning of the spring 41. In this state, the device 61 thus acts as an automatic releasing device.

[0107] The ratchet rim 91 and the gear rim 93 define between them a plurality of locking compartments 95 distributed along the circumference. More specifically, an number of inclined transverse walls 96 are provided between the ratchet rim 91 and the gear rim 93, which transverse walls 96 serve both as partition walls between adjoining locking compartments and as stabilising elements for the ratchet rim 91 and the gear rim 93. In the embodiment shown, the transverse walls 96 are also made in one piece with the end wall 71.

[0108] The locking compartments 95 are adapted to cooperate with a locking pin 97, which is reciprocable in a hole 99 in the supporting rack unit 13. When the locking pin 97 is inserted in a locking compartment 95, it effectively prevents the drum 5 from rotating in an undesired manner. This is of use, for example, in connection with maintenance and transport. The large number of locking compartments 95 provided along the circumference facilitates locking of the drum. If the end wall 71, as is the case here, is provided with locking compartments 95 along its entire circumference, the drum 5 can be manually locked in essentially any rotary position.

[0109] As is best illustrated in Fig. 11, the drum end wall 71 in the example shown has very compact axial dimensions and the ratchet rim 91, the gear rim 93 and the locking compartments 95 as well as the shaft journal 85 are located at least partially in essentially the same radial plane.

[0110] The drum end wall 71 shown in Figs 10 and 11 has several advantages:

- The drum end wall 71 is compact in the axial direction because the ratchet rim 91, the gear rim 93 and the locking compartments 95 are located at least partially in the same radial plane. This makes the reeling device 1 as a whole axially compact. Furthermore, the distance between the drum end wall 71 and the supporting unit 13 is advantageously reduced.
- The construction shown allows the internal gear rim 93 to be positioned far out in the radial direction, which allows for a larger gear rim and, thus, the possibility of using even weaker springs.
- Owing to the integrated design, the ratchet rim 91 and the locking compartments 95, which both act to prevent unintentional rotation of the drum 5, are securely connected to the drum 5, thus effectively preventing any unintentional rotary motion between on the one hand the ratchet rim/locking compartment and, on the other, the drum end wall 71.

The gear rim 93 is also effectively prevented from rotating relative to the rest of the drum 5 by virtue of its integrated design, which, in addition, is obtained by means of a simple and inexpensive manufacturing process.

It will be appreciated that a person skilled in the art can modify the exhaust hose reeling device described above in various ways and still exploit the advantages of the different partial solutions.

The following are examples of conceivable modifications/variants.

- The rack 3 can be designed to have only one rack arm 13, the drum 5 being mounted in a single bearing.
- The supporting rack units 13 and 15 can comprise materials other than a polymer material. They may, for example, be moulded or cast in one piece of aluminium.
- More than one spring can be provided in the spring

housing 41.

- The spring housing can be arranged on the inside of the rack arm, i.e. closest to the drum.
- The downshift transmission can be used in combination with traditional spring cassettes, i.e. without an integrated spring housing 31.
- Optionally, the spring 41 can be mounted in a separate spring cassette, which is then inserted in the spring housing/recess 31 of the rack arm 13. Such a spring cassette may facilitate handling of the spring. If downshift is used, the spring 41 can be weaker and, thus, a lighter construction of such a spring cassette can be used than has previously been possible.
- The downshift transmission can be used in combination with traditional metal racks, i.e. without the integrally formed rack units 13/15.
- The integrated spring housing 31 and/or the integrally formed supporting unit 13 can be used also without a downshift transmission.
- Both drum end walls can be subjected to driving.
- The downshift transmission can be achieved in other ways. For instance, the internal gear rim can be replaced by a gear wheel having an outer row of teeth, which is driven by the gear wheel connected to the spring. Moreover, the ratchet rim 91 can be arranged radially inside the gear rim 93.
- The gear transmission 59/93 can comprise further gear drives.
- In a simpler construction, the gear wheel 59 can be fixedly attached to the spring shaft 53, which means that the setting and safety device 61 can be omitted.
- The transmission can comprise a belt drive or a chain drive, although the gear transmission shown is currently preferred.
- The construction can be modified so that the gear ratio of the downshift transmission varies as a function of the length of hose pulled out.
- Each of the ratchet rim 91, the gear rim 93 and the locking compartments 95 can be carried out independently of the drum end wall 71. As an example, the ratchet rim 91, the gear rim 93 and the transverse walls 96 with the intermediate locking compartments 95 can be manufactured as a separate combined ratchet and drive wheel, optionally of an injection-moulded polymer material or a die-cast aluminium material. Such a combined ratchet and drive wheel can then be mounted as a separate unit on the drum.
- The ratchet rim 91 and/or locking compartments 95 can alternatively be arranged at the opposite drum end wall 73.

[0111] Finally, reference is made to Fig. 16, which illustrates an alternative embodiment. Fig. 16 shows a drum end wall 117 which is provided with a ratchet rim 191 and locking compartments 195 corresponding to the ratchet rim 91 and the locking compartments 95 in the embodiment shown above. However, the drum end wall 117 in Fig. 16 has no internal gear rim. Instead, the drum end wall 117 is adapted to be used in a direct drive embodiment, i.e. without a speed-downshift transmission.

[0112] The drum end wall 117 is preferably made of an injection-moulded polymer material, alternatively a die-cast aluminium material, and has a spring housing 131, preferably made in one piece with the drum end wall 117, for receiving at least one coil spring 141. The outer end of the coil spring 141 engages, in the same way as in the previous embodiment, in a recess 145 in the circumferential wall of the spring housing 131. The inner end 142 of the coil spring 141 drives a shaft that is concentric with the axis of rotation of the drum 5.

[0113] This embodiment has the same advantages in terms of manufacture as the previously shown embodiment as regards the integration of the spring housing 31 in the rack arm 13.

Claims

1. An exhaust hose reeling device (1), comprising an exhaust hose (2), a rotatably mounted drum (5) for winding in and reeling out the exhaust hose (2), and a shaft (53), called spring shaft (53), which is driven by at least one spring means (41) adapted to wind in the exhaust hose (2) and having an inner end and an outer end (43), the inner end of the spring means (41) being connected to the spring shaft (53) and the spring means (41) comprising least one coil spring (41), **characterised in that** the reeling device is such that a downshift occurs, at least when the exhaust hose (2) is wound in, which is such that the speed of the spring shaft (53), relative to the outer end (43) of the spring means (41) is higher than the speed of the drum (5), that the reeling device further comprises a downshift transmission means (59/93) comprising a downshift gear transmission (59/93) for performing said downshift, wherein said downshift gear transmission (59/93) comprises a gear wheel (59), which is driven by the spring shaft (53), and an internal gear rim (93), which is driven by said gear wheel (59).

2. A reeling device according to claim 1, wherein the gear wheel (59) is mounted on the spring shaft (53).

3. A reeling device according to claim 1 or 2, wherein the internal gear rim (93) is concentric with the drum (5).

4. A reeling device according to any one of claims 1-3, wherein the internal gear rim (93) is mounted on the outside of a drum end wall (71).

5. A reeling device according to claim 4, wherein the internal gear rim (93) is made in one piece with said drum end wall (71).

6. A reeling device according to claim 5, wherein the internal gear rim (93) and said drum end wall (71) are made in one piece of a material comprising at least one of a polymer material and an aluminium material.

7. A reeling device according to any one of the preceding claims, wherein the spring means (41) is dimensioned in such manner that, in an imaginary direct drive construction without said downshift, it would not allow the hose to be wound in.

8. A reeling device according to any one of the preceding claims, wherein the spring means (41) is dimensioned in such manner that it exerts a moment of force on the spring shaft (53) not exceeding 20 Nm, preferably not exceeding 15 Nm.

9. A reeling device according to any one of the preceding claims, further comprising a rack arm (13), which supports the drum (5) and which is formed with a space (31), called spring housing, for receiving said spring means (41).

10. A reeling device according to claim 9, wherein the spring housing (31) of the rack arm (13) is formed by an essentially cylindrical circumferential wall (33) and a bottom wall (35).

11. A reeling device according to claim 10, wherein the circumferential wall (33) and the bottom wall (35) of the spring housing (31) are made in one piece with the rack arm (13).

12. A reeling device according to any one of claims 9-11, wherein the rack arm (13) is made of a material comprising at least one of a polymer material and an aluminium material.

13. A reeling device according to any one of claims 9-12, wherein the spring shaft (53) is extended through an opening (51) in the bottom wall (35) of the spring housing (31).

14. A reeling device according to any one of claims 9-13, wherein the spring housing (31) is at least partially recessed in the rack arm (13).

15. A reeling device according to any one of the preceding claims, wherein the spring shaft (53) is eccentrically arranged relative to the axis of rotation (L3) of the drum (5).

16. A reeling device according to any one of the preceding claims, wherein the spring means (41) comprises at least one coil spring (41) and wherein the spring shaft (53) is eccentrically arranged relative to the coil spring (41).

Patentansprüche

1. Abgasschlauchaufwickelvorrichtung (1), die einen Abgasschlauch (2), eine drehbar montierte Trommel (5) für das Aufwickeln und Auswickeln des Abgasschlauches (2) und einen durch mindestens eine Federeinrichtung (41) angetriebenen Schaft (53), Federschaft (53) genannt, die zum Aufwickeln des Abgasschlauches (2) angepasst ist und ein inneres Ende und ein äußeres Ende (43) besitzt, wobei das innere Ende der Federeinrichtung(41) mit dem Federschaft (53) verbunden ist, umfasst und wobei die Federeinrichtung (41) mindestens eine Schraubenfeder (41) umfasst,
dadurch gekennzeichnet, dass
die Aufwickelvorrichtung so ausgelegt ist, dass eine Verlangsamung wenigstens dann stattfindet, wenn der Abgasschlauch (2) aufgewickelt ist, welche so ausgelegt ist, dass die Geschwindigkeit des Federschaftes (53) hinsichtlich des äußeren Endes (43) der Federeinrichtung (41) höher ist als die Geschwindigkeit der Trommel (5), dass die Aufwickelvorrichtung außerdem eine Verlangsamungsübertragungseinrichtung (59/93) umfasst, die eine Herunterschaltübertragung(59/93) zum Durchführen der Verlangsamung umfasst, wobei die Herunterschaltübertragung (59/93) ein durch den Federschaft (53) angetriebenes Getrieberad (59) und einen durch das Getrieberad (59) angetriebenen inneren Zahnkranz (93) umfasst.

2. Aufwickelvorrichtung gemäß Anspruch 1, wobei das Getrieberad (59) auf dem Federschaft (53) montiert ist.

3. Aufwickelvorrichtung gemäß Anspruch 1 oder 2, wobei der innere Zahnkranz (93) mit der Trommel (5) konzentrisch ist.

4. Aufwickelvorrichtung gemäß einem der Ansprüche 1-3, wobei der innere Zahnkranz (93) auf der Außenseite einer Trommelendwand (71) montiert ist.

5. Aufwickelvorrichtung gemäß Anspruch 4, wobei der innere Zahnkranz (93) einstückig mit der Trommelendwand (71) hergestellt ist.

6. Aufwickelvorrichtung gemäß Anspruch 5, wobei der innere Zahnkranz (93) und die Trommelendwand (71) einstückig aus einem Material hergestellt sind, das mindestens eines von einem Polymermaterial und einem Aluminiummaterial umfasst.

7. Aufwickelvorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Federeinrichtung (41) derart dimensioniert ist, dass in einer imaginären direkten Betriebskonstruktion ohne die Verlangsamung, diese ein Aufwickeln des Schlauches nicht

erlauben würde.

8. Aufwickelvorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Federeinrichtung (41) derart dimensioniert ist, dass sie ein Kraftmoment auf den Federschaft (53) ausübt, das 20 Nm vorzugsweise 15 Nm nicht übersteigt.

9. Aufwickelvorrichtung gemäß einem der vorhergehenden Ansprüche, die außerdem einen Gestellarm (13) umfasst, welcher die Trommel (15) trägt und welcher mit einem Raum (31), Federgehäuse genannt, zum Empfangen der Federeinrichtung (41) gebildet ist.

10. Aufwickelvorrichtung gemäß Anspruch 9, wobei das Federgehäuse (31) des Gestellarmes (13) durch eine im wesentlichen zylindrisch umlaufende Wand (33) und eine Bodenwand (35) gebildet ist.

11. Aufwickelvorrichtung gemäß Anspruch 10, wobei die umlaufende Wand (33) und die Bodenwand (35) des Federgehäuses (31) einstückig mit dem Gestellarm (13) hergestellt sind.

12. Aufwickelvorrichtung gemäß einem der Ansprüche 9-11, wobei der Gestellarm (13) aus einem Material hergestellt ist, das mindestens eines von einem Polymermaterial und einem Aluminiummaterial umfasst.

13. Aufwickelvorrichtung gemäß einem der Ansprüche 9-12, wobei sich der Federschaft (53) durch eine Öffnung (51) in der Bodenwand (35) des Federgehäuses (31) erstreckt.

14. Aufwickelvorrichtung gemäß einem der Ansprüche 9-13, wobei das Federgehäuse (31) mindestens teilweise in den Gestellarm (13) eingelassen ist.

15. Aufwickelvorrichtung gemäß einem der vorhergehenden Ansprüche, wobei der Federschaft (53) exzentrisch relativ zu der Rotationsachse (L3) der Trommel (5) angeordnet ist.

16. Aufwickelvorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Federeinrichtung (41) mindestens eine Schraubenfeder (41) umfasst und wobei der Federschaft (53) exzentrisch relativ zu der Schraubenfeder (41) angeordnet ist.

Revendications

1. Dispositif d'enroulement (1) de tuyau d'échappement, comprenant un tuyau d'échappement (2), un tambour monté de manière rotative (5) destiné à enrouler et à dérouler le tuyau d'échappement (2), et un arbre (53), appelé arbre de ressort (53), qui est entraîné par au moins un moyen de ressort (41) adapté pour enrouler le tuyau d'échappement (2) et ayant une extrémité intérieure et une extrémité extérieure (43), l'extrémité intérieure du moyen de ressort (41) étant reliée à l'arbre de ressort (53) et le moyen de ressort (41) comprenant au moins un ressort hélicoïdal (41), **caractérisé en ce que** le dispositif d'enroulement est tel qu'une rétrogradation survient, au moins lorsque le tuyau d'échappement (2) est enroulé, qui est telle que la vitesse de l'arbre de ressort (43) par rapport à l'extrémité extérieure (43) du moyen de ressort (41) est supérieure à la vitesse du tambour (5), **en ce que** le dispositif d'enroulement comprend en outre un moyen de transmission de rétrogradation (59/93) comprenant une transmission à engrenage de rétrogradation (59/93) pour effectuer ladite rétrogradation, dans lequel ladite transmission à engrenage de rétrogradation (59/93) comprend une roue dentée (59), laquelle est entraînée par l'arbre de ressort (53), et une jante dentée interne (93), qui est entraînée par ladite roue dentée (59).

2. Dispositif d'enroulement selon la revendication 1, dans lequel la roue dentée (59) est montée sur l'arbre de ressort (53).

3. Dispositif d'enroulement selon la revendication 1 ou 2, dans lequel la jante dentée interne (93) est concentrique avec le tambour (5).

4. Dispositif d'enroulement selon l'une quelconque des revendications 1 à 3, dans lequel la jante dentée interne (93) est montée sur l'extérieur de la paroi d'extrémité de tambour (71).

5. Dispositif d'enroulement selon la revendication 4, dans lequel la jante dentée interne (93) est composée d'un seul tenant avec ladite paroi d'extrémité de tambour (71).

6. Dispositif d'enroulement selon la revendication 5, dans lequel la jante dentée interne (93) et ladite paroi d'extrémité de tambour (71) sont composées d'un seul tenant d'un matériau comprenant au moins un matériau parmi un matériau polymère et un matériau aluminium.

7. Dispositif d'enroulement selon l'une quelconque des revendications précédentes, dans lequel le moyen de ressort (41) est dimensionné d'une manière telle que, dans une construction d'entraînement direct imaginaire sans ladite rétrogradation, il ne permet pas au tuyau d'être enroulé.

8. Dispositif d'enroulement selon l'une quelconque des revendications précédentes, dans lequel le moyen

de ressort (41) est dimensionné d'une manière telle qu'il exerce un moment de force sur l'arbre de ressort (53) ne dépassant pas 20 Nm, de préférence ne dépassant pas 15 Nm.

9. Dispositif d'enroulement selon l'une quelconque des revendications précédentes, comprenant en outre un bras de crémaillère (13), qui supporte le tambour (5) et qui est formé avec un espace (31), appelé logement de ressort, destiné à recevoir ledit moyen de ressort (41).

10. Dispositif d'enroulement selon la revendication 9, dans lequel le logement de ressort (31) du bras de crémaillère (13) est formé par une paroi circonférentielle essentiellement cylindrique (33) et une paroi inférieure (35).

11. Dispositif d'enroulement selon la revendication 10, dans lequel la paroi circonférentielle (33) et la paroi inférieure (35) du logement de ressort (31) sont composées d'un seul tenant avec le bras de crémaillère (13).

12. Dispositif d'enroulement selon l'une quelconque des revendications 9 à 11, dans lequel le bras de crémaillère (13) est composé d'un matériau comprenant au moins l'un parmi un matériau polymère et un matériau aluminium.

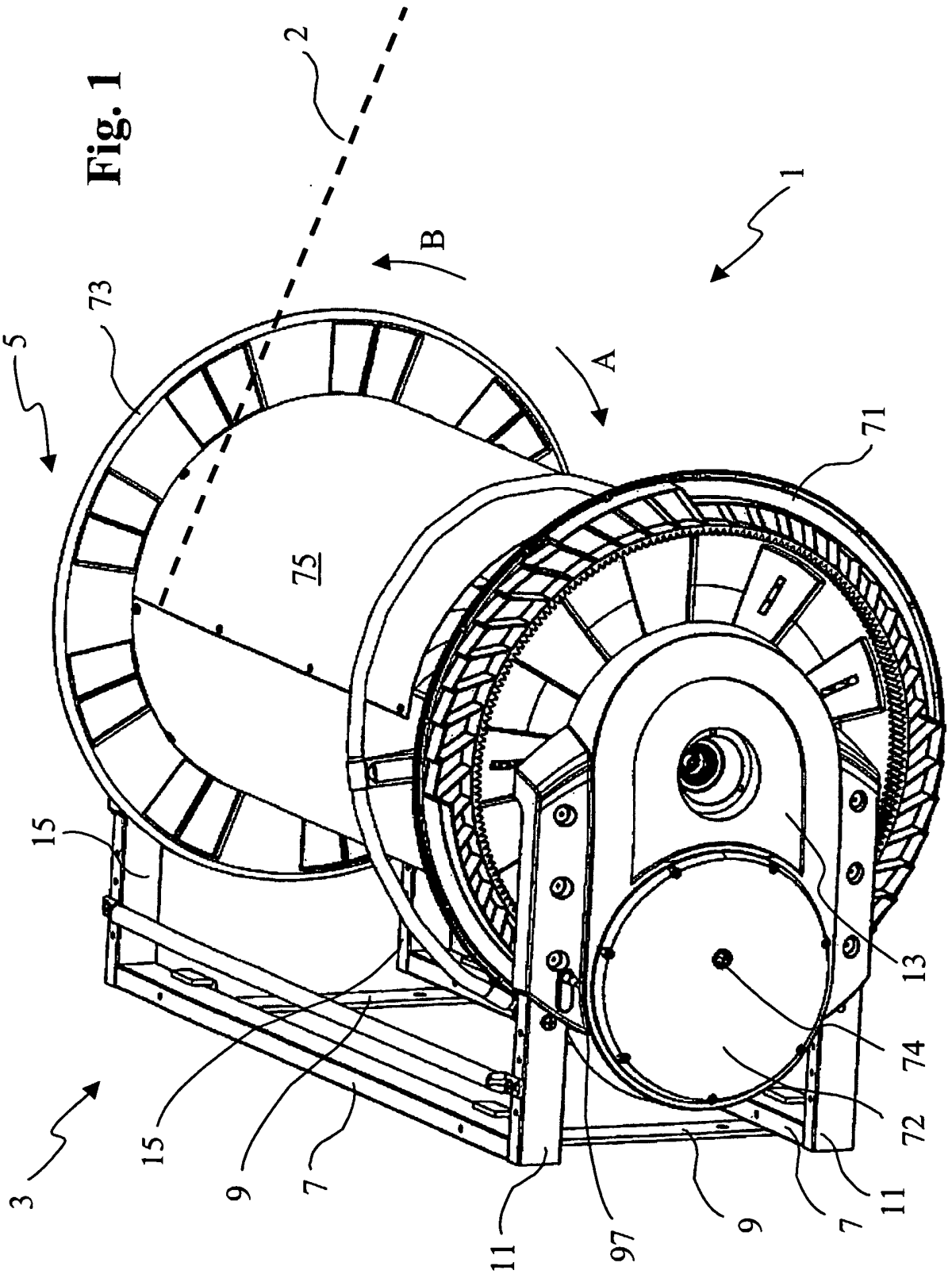
13. Dispositif d'enroulement selon l'une quelconque des revendications 9 à 12, dans lequel l'arbre de ressort (53) est étendu à travers une ouverture (51) dans la paroi inférieure (35) du logement de ressort (31).

14. Dispositif d'enroulement selon l'une quelconque des revendications 9 à 13, dans lequel le logement de ressort (31) est au moins partiellement évidé dans le bras de crémaillère (13).

15. Dispositif d'enroulement selon l'une quelconque des revendications précédentes, dans lequel l'arbre de ressort (53) est excentriquement agencé par rapport à l'axe de rotation (L3) du tambour (5).

16. Dispositif d'enroulement selon l'une quelconque des revendications précédentes, dans lequel le moyen de ressort (41) comprend au moins un ressort hélicoïdal (41) et dans lequel l'arbre de ressort (53) est excentriquement agencé par rapport au ressort hélicoïdal (41).

Fig. 1



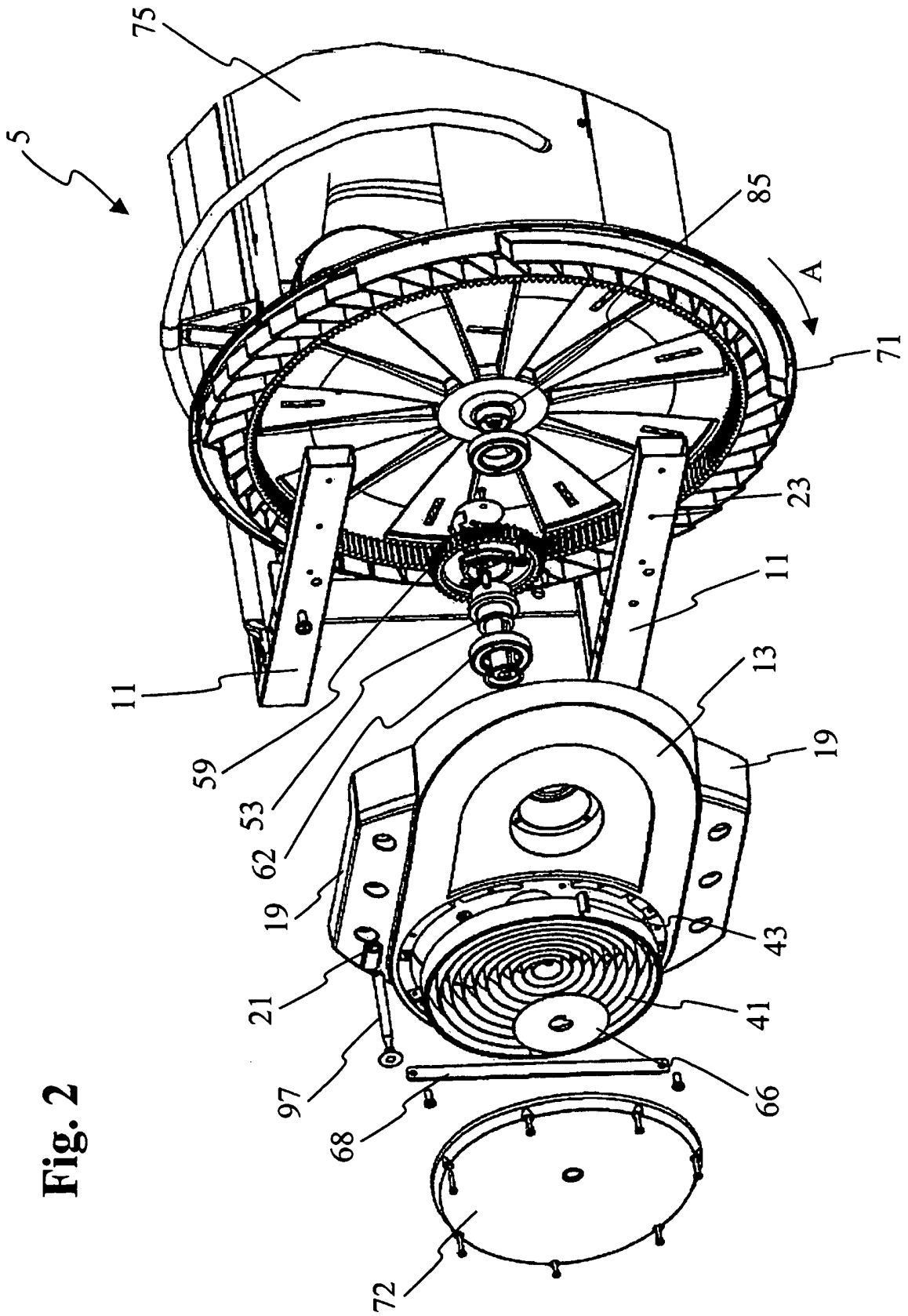


Fig. 2

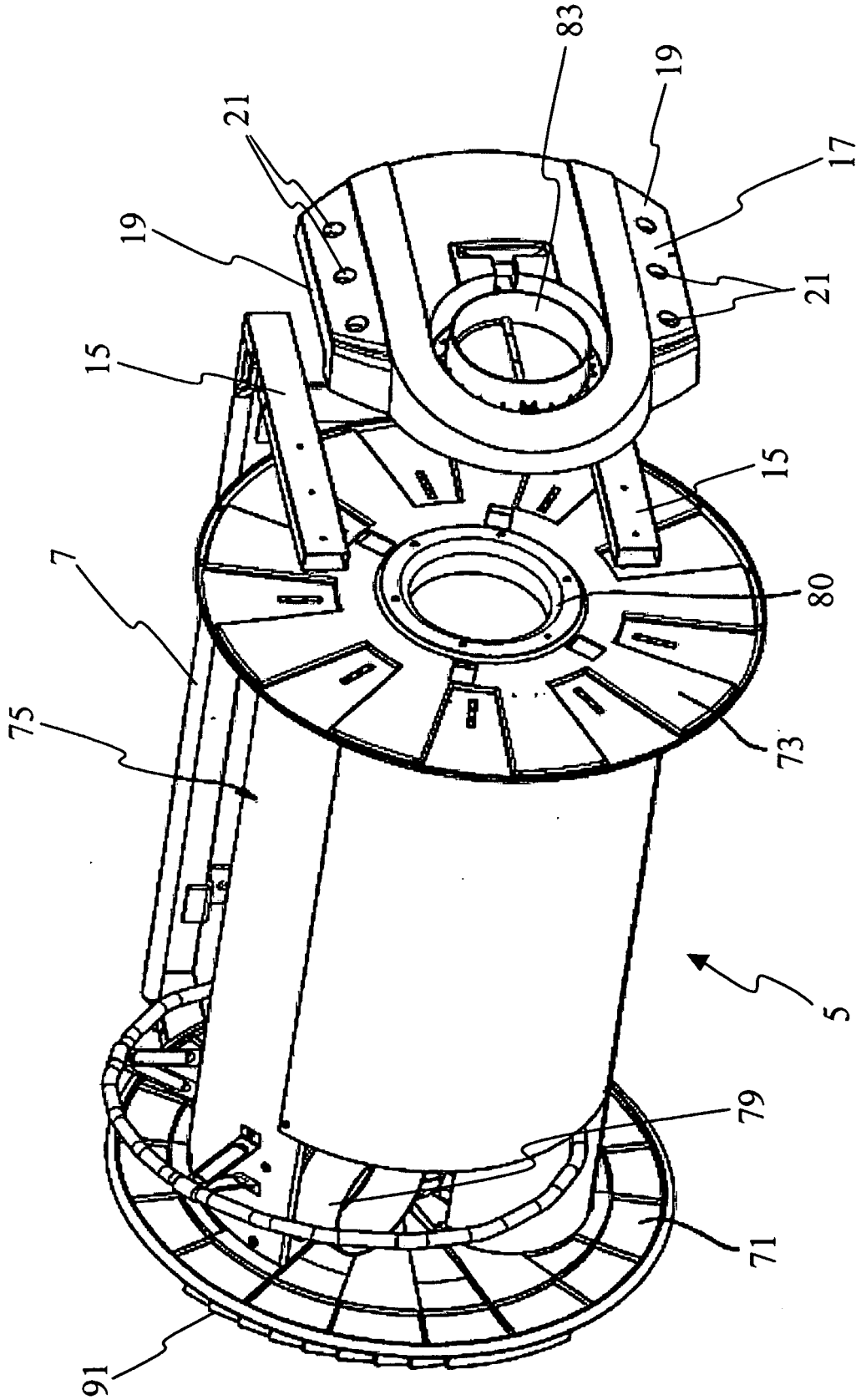


Fig. 3

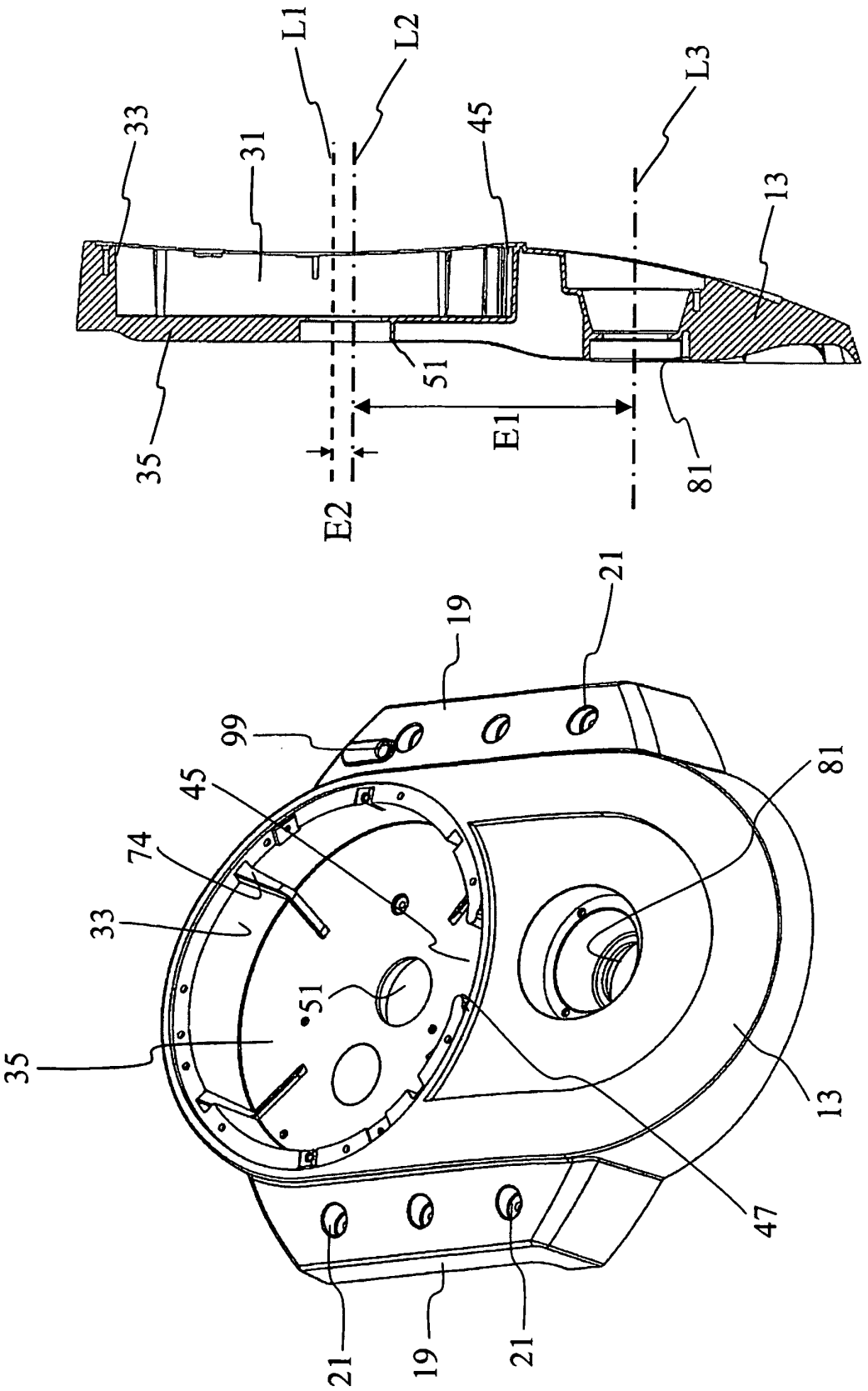


Fig. 5

Fig. 4

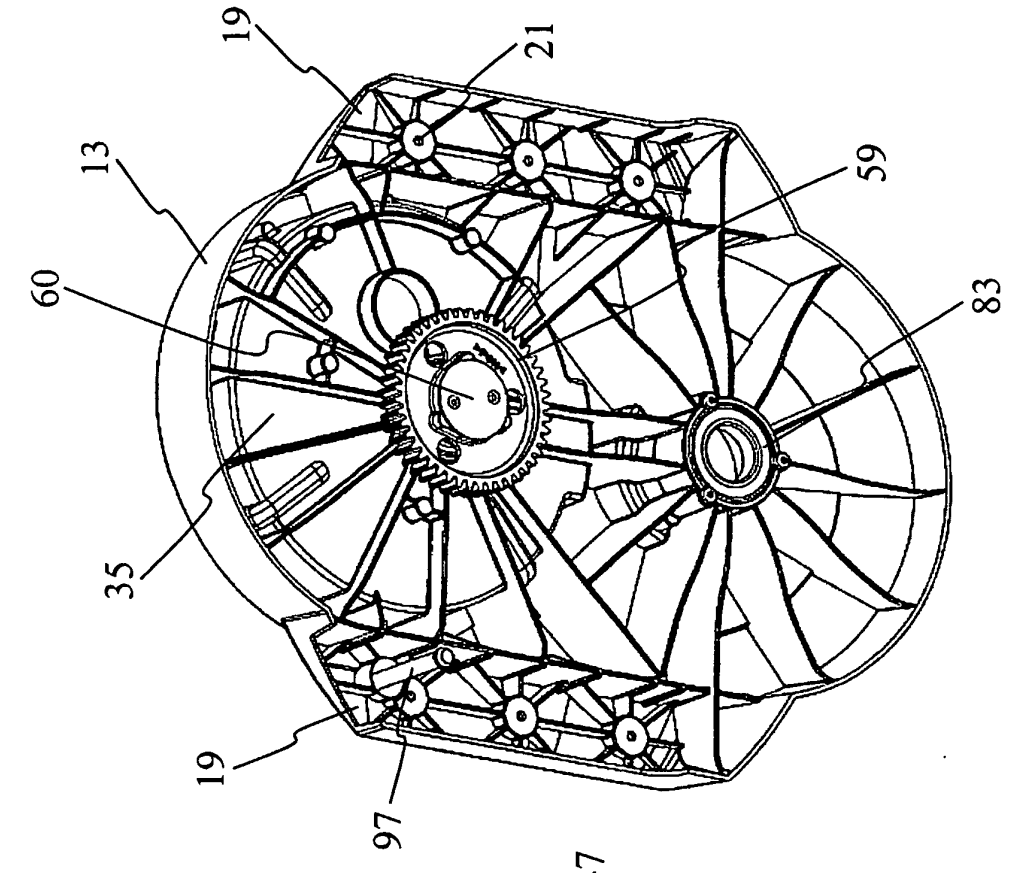


Fig. 7

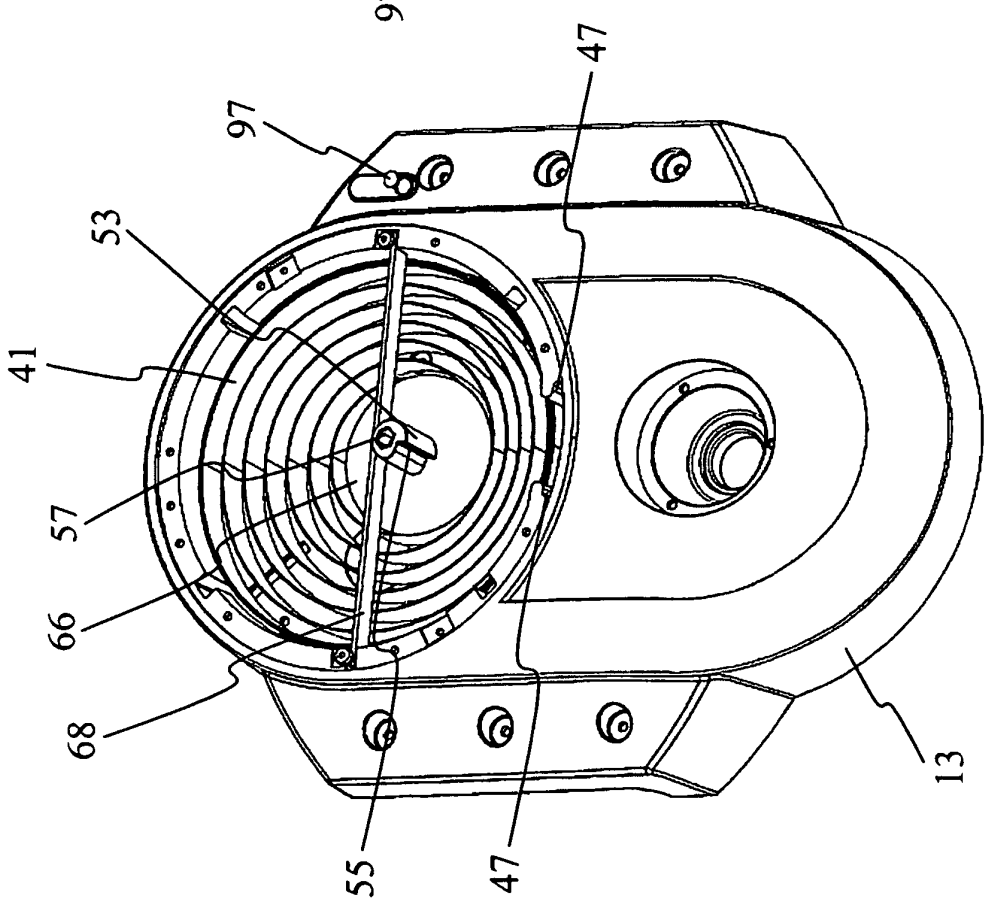


Fig. 6

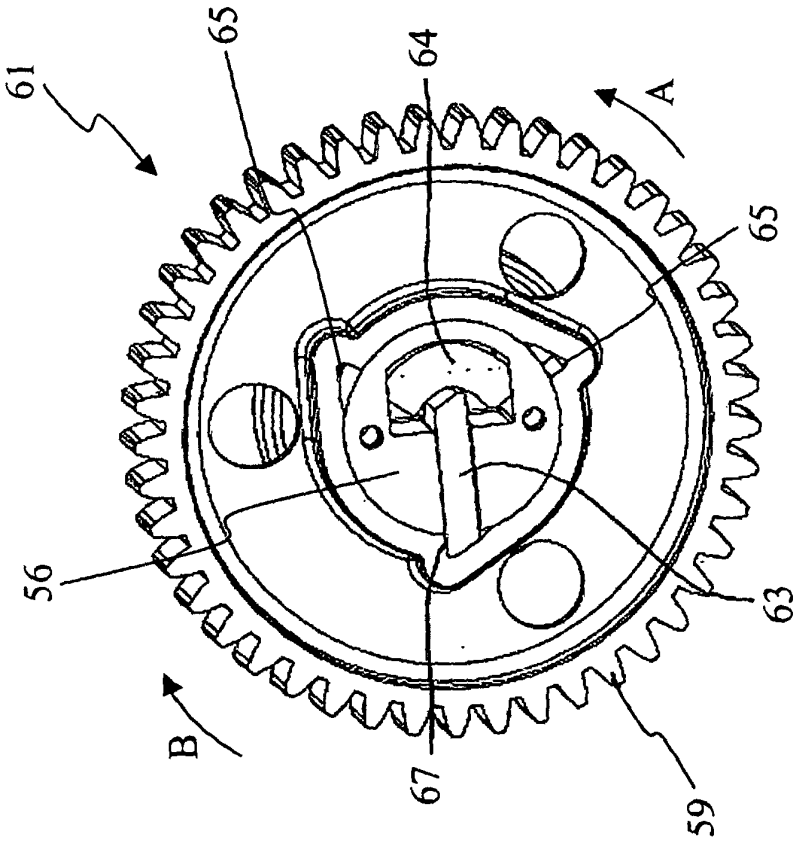

61
65
64
A
65
56
63
B
67
59

Fig. 9

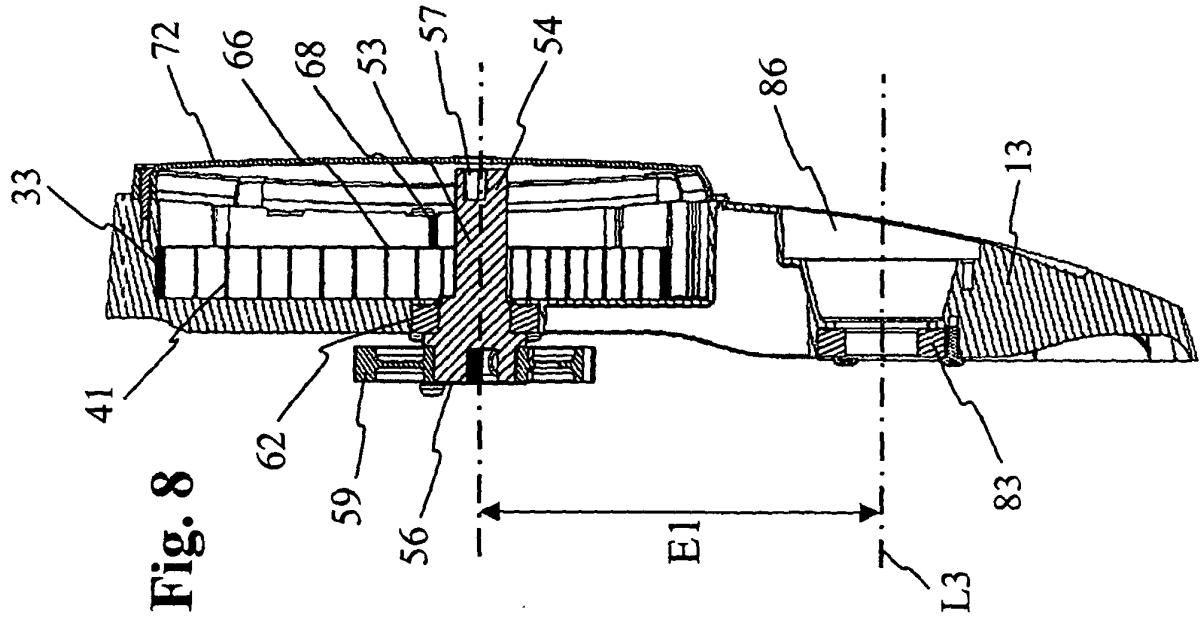

72
66
68
53
57
54
86
33
13
41
62
59
56
E1
L3
83

Fig. 8

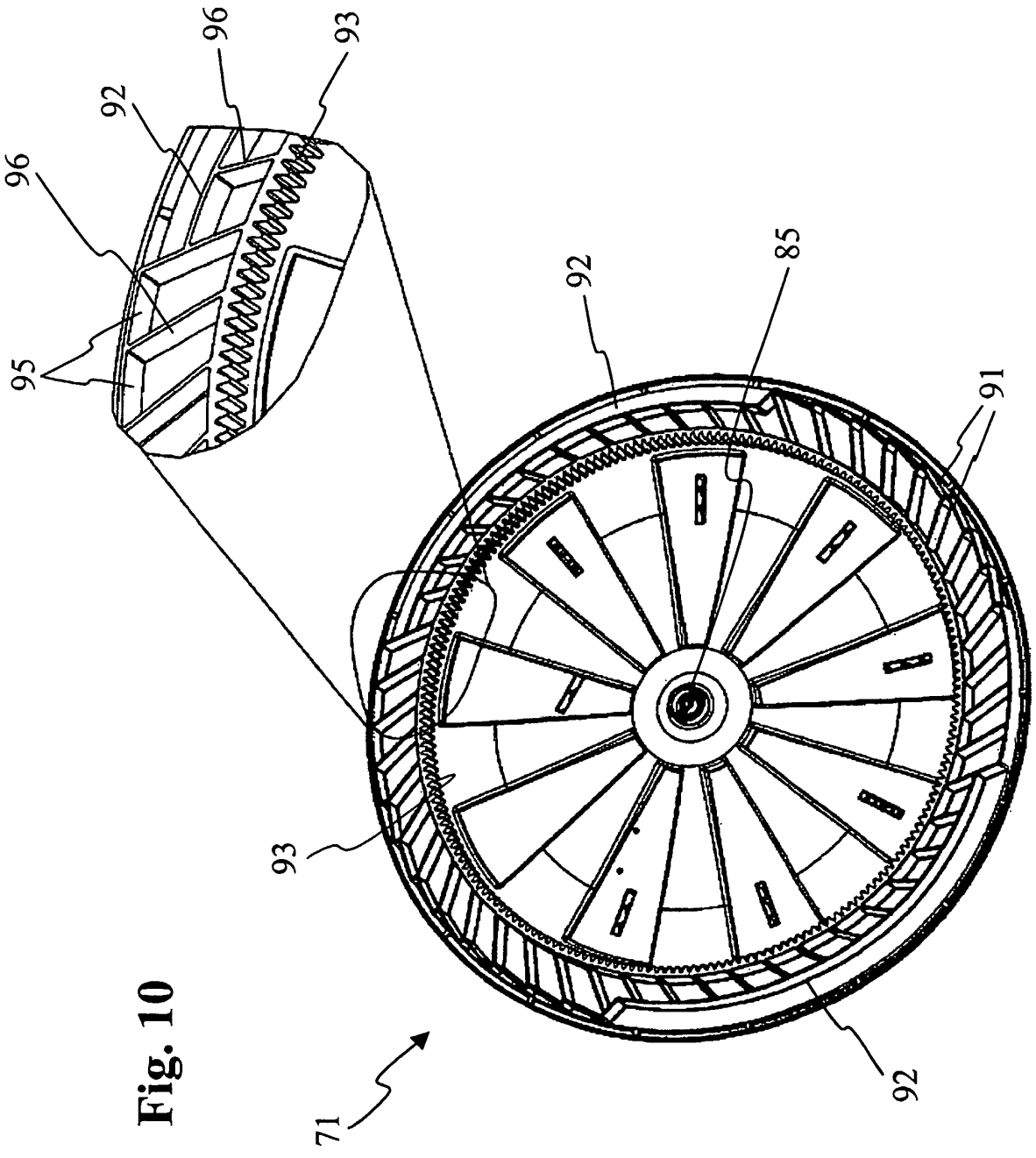


Fig. 10

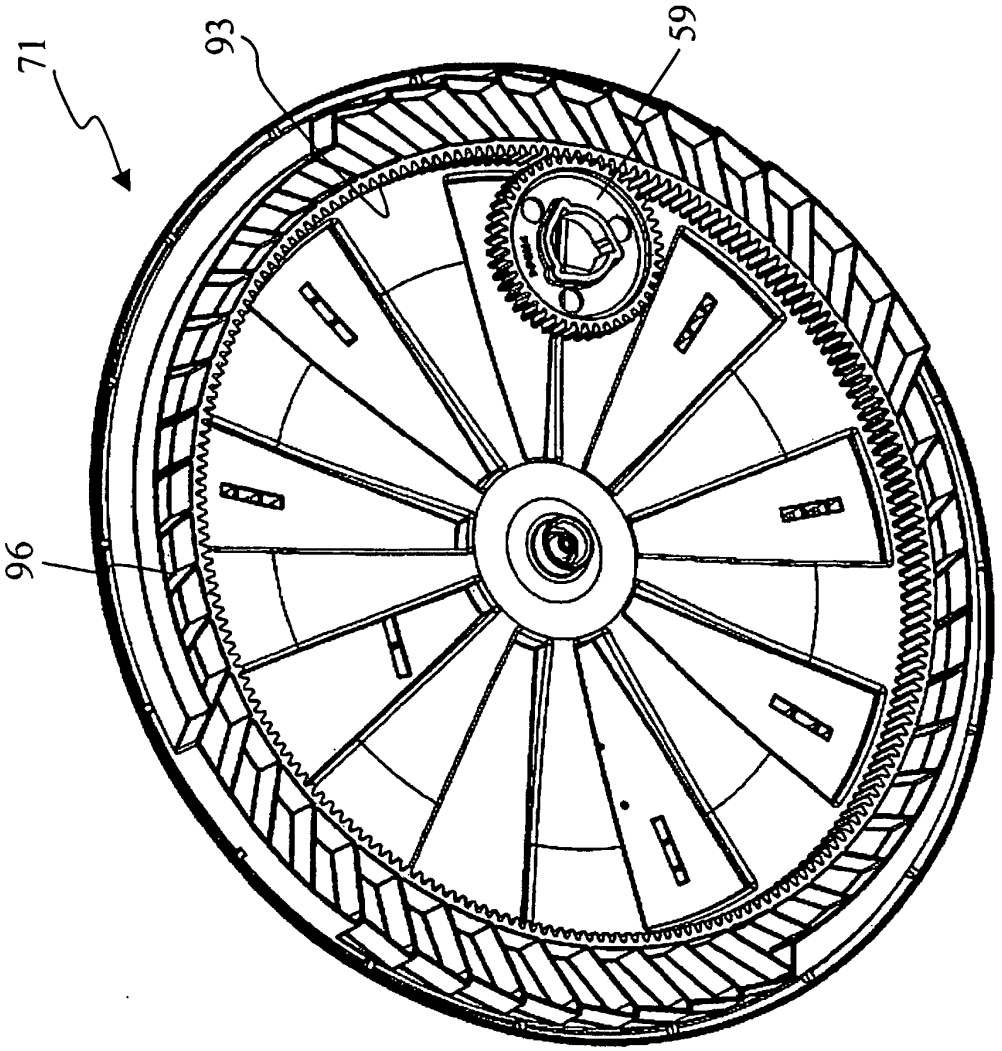


Fig. 12

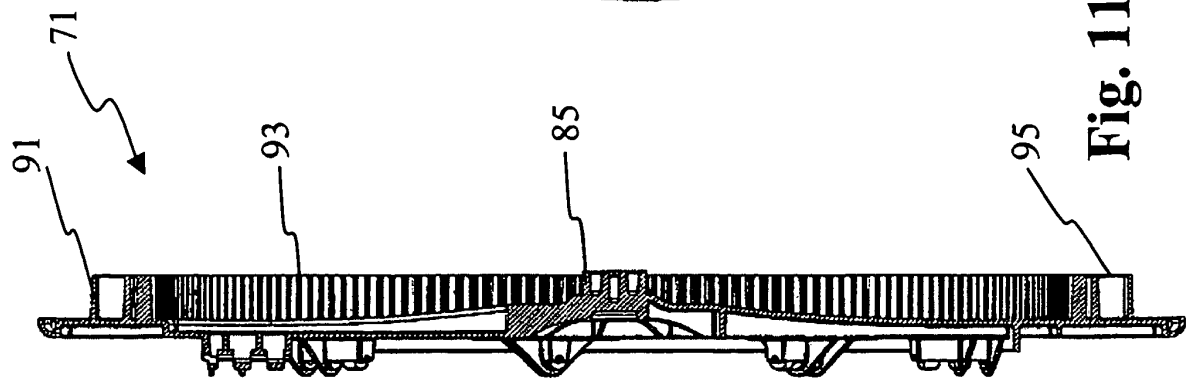


Fig. 11

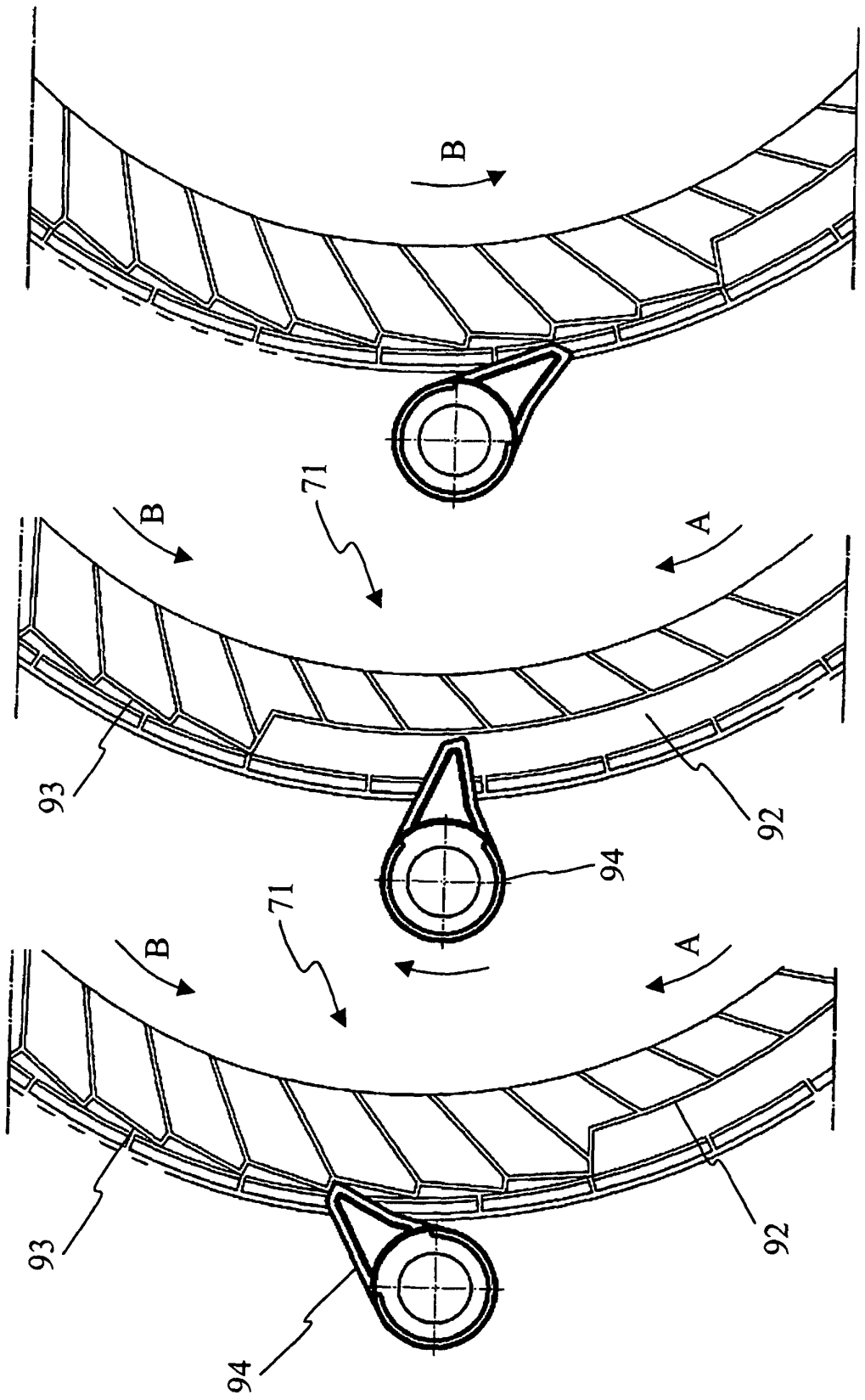


Fig. 15

Fig. 14

Fig. 13

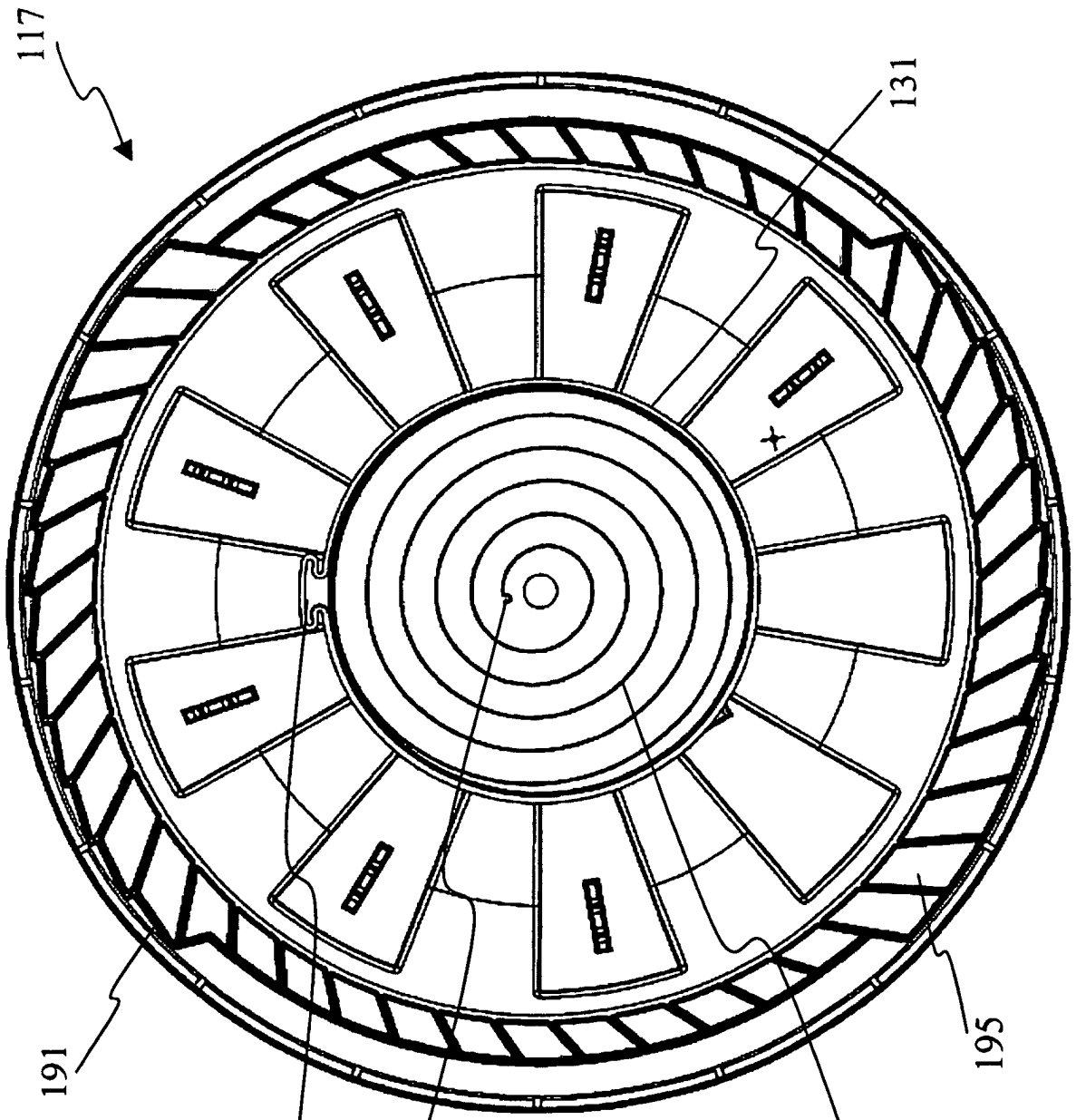


Fig. 16