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(54) **BELT RETRACTOR FOR A VEHICLE SAFETY BELT**

GURTAUFROLLER FÜR EINEN FAHRZEUGSICHERHEITSGURT

RÉTRACTEUR DE CEINTURE POUR CEINTURE DE SÉCURITÉ DE VÉHICULE

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Description

[0001] The invention relates to a belt retractor for a vehicle safety belt, in which a safety belt reel is rotatably mounted on a frame and which includes a load limiter which acts on a rotational movement of the belt reel and has a switchable energy consumption.

[0002] In such a prior art safety belt retractor known from DE 10 2009 014 999 A1, the load limiter contains a brake with which relative rotation between the element to be braked and a support element produces a rise in pressure inside a pressure chamber, which is then converted into an brake actuating force. A medium which is filled into the pressure chamber may be silicone, or more specifically a silicone granulate, the particle diameter of which is approximately 0.2 to 0.3 mm and by means of which an axially mobile displacement element can be partly sheared. The displacement element displaces the medium provided in the pressure chamber, thus cause the rise in pressure in the pressure chamber, which is then converted into the brake actuation force. In this prior art load limiter, load limitation is performed by the brake only, and not by the medium.

[0003] Dokument WO 2011082757 discloses a belt retractor according to the preamble of claim 1.

[0004] The purpose of the load limiter is to limit the forces acting during an accident between the safety belt and the vehicle passenger wearing the safety belt and who is moved further forwards in the motor vehicle seat.

[0005] The object of the invention is to provide a belt retractor in which the load limiting effect is automatically adjusted, depending on the vehicle passenger data and the severity of the respective accident.

[0006] This object is achieved, according to the invention, by the features of claim 1.

[0007] The dependent claims contain advantageous developments of the invention.

[0008] Embodiments shall now be described in detail with reference to the Figures, in which

Figure 1: shows a belt retractor for a vehicle safety belt, comprising a built-in load limiter which is one embodiment;

Figure 2: shows schematically, in an exploded view, components which are used in the embodiment in Figure 1;

Figures 3A-3D: show forms of rotating members which may be used in the embodiment according to Figures 1 and 2;

Figure 4: shows a cutaway view along the axis of the belt reel in a further embodiment;

Figure 5: shows a cross-sectional view along line A-A in the embodiment shown in Figure 4;

Figure 6: shows another embodiment;

Figure 7: shows yet another embodiment;

Figure 8: shows a cutaway view of another embodiment;

Figure 9: shows a cross-sectional view along line C-C in Figure 8;

Figure 10: shows cutaway view of another embodiment;

Figure 11: shows a cross-sectional view along line A-A in Figure 10;

Figure 12: shows cutaway view of another embodiment;

Figure 13: shows a cross-sectional view along line F-F in Figure 12;

Figure 14: shows a cross-sectional view along line G-G in Figure 12; and

Figure 15: shows a cutaway view of yet another embodiment;

Figure 16: shows in cutaway view a further embodiment of the invention, in which a displacer body linearly moveable in the load limiter chamber and a progressive transmission gear are used;

Figure 17: shows a side view of the embodiment shown in Fig. 16;

Figure 18: shows cutaway view of a further embodiment having a progressive transmission gear;

Figure 19: shows a further embodiment having a progressive transmission gear, Figure 21 shows a further embodiment;

Figure 20: shows a cutaway view of a belt retractor comprising a built in load limiter according to the invention.

[0009] In the embodiments shown, the belt retractor in each case has a frame 7, on which safety belt reel 1 for a motor vehicle is rotatably mounted. The belt retractor also contains a load limiter 2, which acts on a rotational movement of belt reel 1 in an accident and consumes energy thereby.

[0010] Load limiter 2 has a closed load limiter chamber 8, in which a granulate 3 is enclosed. Granulate 3 consists of a dry, granular solid. The granules of granulate may have a specific hardness equivalent to a Mohs hardness of at least 4 (absolute abrasive hardness: 5). For example, the granules of granulate consist of mineral granules, such as quartz (SiO_2) sand. However, the granules of granulate may also consist of plastic, glass or metallic material. The diameter of the substantially rounded granules of granulate ranges between 0.1 and 0.4 mm. The granules of granulate may also consist of different materials and/or have different hardnesses.

[0011] Load limiter 2 also has a rotating member 4, which is disposed in load limiter chamber 8 and is rotatable relative to granulate 3. Rotating member 4 is in rotary drive communication with belt reel 1. To that end, rotating member 4 is connected non-rotatingly to belt reel 1, as shown in the embodiment in Figures 4 - 7, or is in drive communication with belt reel 1 via a transmission gear and/or a switchable coupling. This may be the case in

the embodiments shown in Figures 1 and 2, for example. However, a rotatable drive connection may be provided between rotating member 4 and belt reel 1 in this embodiment also.

[0012] One or more rotating members 4 may be in drive communication with belt reel 1.

[0013] The at least one rotating member 4 is preferably disposed fixedly in the direction of its rotational axis 5, in relation to load limiter chamber 8 and in particular in relation to belt reel 1 as well.

[0014] As shown in Figures 3A - 3D, rotating member 4 may have different shapes. For example, the rotating member may be disc-shaped, with radially extending ribs on one or both disc surfaces (Figure 3A). In the embodiment shown in Figure 3B, rotating member 4 is in the form of a hexagonal rotating member. In the example shown in in Figure 3C, rotating member 4 is embodied as a rotor with two vanes. In the embodiment in Figure 3D, rotating member 4 is in the form of an impeller, the embodiment shown having six vanes. The vanes may be curved, as shown in Figure 3D. However, the vanes may also extend in a straight radial line. The vanes may also have a twist or screw.

[0015] The at least one rotating member 4 is preferably dipped wholly or partially into granulate 3. In the embodiment in Figure 3A, the radially extending ribs on the disc-shaped rotating member 4 are fully submerged in granulate 3. In the embodiment in Figure 3B, at least the hexagonal circumferential surface of rotating member 4 are submerged fully in the granulate. In the embodiment shown in Figure 3C, at least the circumferential surfaces 13 of the two vanes are fully submerged in granulate 3. In the embodiment in Figure 3D, at least the circumferential surfaces 13 on each vane of the impeller are likewise dipped into or submerged in granulate 3.

[0016] The belt reel consists substantially of two belt reel parts 11 and 14. The one belt reel part 11 can be blocked from further rotation relative to frame 7 in the event of excessive acceleration or braking, for example in an accident. This can be achieved in a known manner by means of a belt strap-sensitive and/or vehicle-sensitive blocking mechanism 16 (Figures 8 and 10). The other belt reel part 14 is rotatable relative to the blocked belt reel part 11, load limiter 2 acting between the blocked belt reel part 11 and the rotatable belt reel part 14 when the safety belt is pulled out.

[0017] In the embodiments shown in den Figures 4-11, belt reel 1 contains the belt reel part 11 which can be blocked relative to frame 7 and the belt reel part 14 which is rotatable In relation to the blocked belt reel part 11. In normal operation, the entire belt reel 1, i.e. both the blockable belt reel part 11 and the rotatable belt reel part 14, are rotatably mounted on frame 7, together with the load limiter disposed in load limiter chamber 8. In the embodiment shown in Figures 4 and 5, load limiter 2 extends inside a substantially circular cylindrical load limiter chamber 8 along belt reel axis 5. On the inner wall of the sleeve- or pot-shaped rotatable belt reel part 14, there are tooth-like projections protruding into granulate 3 and forming a plurality of rotating members 4 on rotatable belt reel part 14, which are rotatable about belt reel axis 5 and which are dipped into granulate 3. Said rotating members 4 extend substantially radially inwardly into granulate 3 and are provided on the outer boundary wall of load limiter chamber 8. Projections may also be provided on the radially inner boundary surface of load limiter chamber 8. Said radially inner boundary surface of load limiter chamber 8 is formed by a sleeve-shaped stator 12 which is joined non-rotatingly to blockable belt reel part 11. However, it Is also possible for the radially inner boundary surface of load limiter chamber 8, which is provided on the sleeve-shaped stator 12, to be embodied in a smooth form. In an accident, the blockable belt reel part 11 and stator 12 are preventing from rotating relative to frame 7. Depending on the severity of the accident and the body size and weight of the vehicle passenger wearing the seat belt, the safety belt is unreeled from the belt reel, the rotatable belt reel part 14 rotating relative to the blocked belt reel part 11, and the projections on the inner side of the rotatable belt reel part 14, which form rotating member 4, are rotated relative to granulate 3. Shear force are exerted in the process on the granules of the granulate, which absorb energy and thus impose a limitation on the forces acting between the body of the vehicle passenger who has been moved forwards and the unreeled belt strap.

[0018] As shown in Figures 4, 5 and 8 - 11, a torsion bar 6 disposed inside the sleeve-shaped load limiter arrangement may additionally be provided. The one end (the left-hand end of torsion bar 6) is joined non-rotatingly to the blockable belt reel part 11, and the other end (the right-hand end of torsion bar 6) is non-rotatingly joined to rotatable belt reel part 14.

[0019] In the embodiments shown in Figures 6 - 9, the load limiter chamber 8 is located between two opposite end faces on blockable belt reel part 11 and on rotatable belt reel part 14 (Figures 6, 7, 10, 11) or on blockable belt reel part 11 (Figures 8, 9). The end face on rotatable belt reel part 14 may lie in a hollow disposed rotationally symmetrically In respect of belt reel axis 5. Granulate 3 is located in load limiter chamber 8, and the rotating members 4 embedded in granulate 3 are located on the countersunk end face of rotatable belt reel part 14 in Figure 6, in the form of substantially radially extending projections. On the opposite end face of blockable belt reel part 11, substantially radially extending projections which likewise protrude into granulate 3 and which produce the effects of stator 12 may be provided.

[0020] In these embodiments also, a load limiting effect is produced when the rotatable belt reel part 14 is rotated in relation to the blocked belt reel part 11, said effect being caused by the shear forces which are produced by the rotating members 4 which act as axial projections in granulate 3.

[0021] Instead of the projections acting as rotating member 4, one of the rotating members 4 shown in Fig-

ures 3A - 3D may also be disposed in the load limiter chamber 8 at the end face (Figures 7-11). In the embodiment in Figure 7, said rotating member is disposed non-rotatingly on a stub shaft 15 of rotatable belt reel part 14. A rotating member in the form of an impeller, as shown in Figure 3D, is preferably disposed in load limiter chamber 8. In the embodiment in Figure 7, load limiter chamber 8 and granulate 3 are arranged in a recess in blockable belt reel part 11. In Figure 7, as in the embodiment in Figures 4 and 5, the one end of a torsion bar may be joined non-rotatingly to blockable belt reel part 11. The other end of the torsion bar is connected to rotatable belt reel part 14. The torsion bar extends along belt reel axis 5 in a cavity in stub shaft 15 and rotatable belt reel part 14.

[0022] In the embodiments shown In Figures 8 - 11, the torsion bar extends as a component of load limiter 2 along the rotational axis 5 of the belt reel. At one end (the left-hand end), torsion bar 6 is connected non-rotatingly to rotatable belt reel part 14. In the embodiment in Figures 8 and 9, the other end (the right-hand end) of the torsion bar is connected via a break point 17 to blockable belt reel part 11. Said right-hand end of torsion bar 6 is also joined non-rotatingly to rotating member 4, which is provided in the form of an impeller. In this embodiment, torsion bar 6 acts as a a load limiter, up to a particular load threshold determined by break point 17. When the load threshold is exceeded, the connection between torsion bar 6 and blocked belt reel part 11 is broken, with the result that rotating member 4 is rotated with load limitation in the granulate located inside load limiter chamber 8. The rotational movement is transmitted from the rotatable belt reel part 14 via torsion bar 6 to rotating member 4. Load limiter chamber 8 containing granulate 3 is disposed in a recess in blockable belt reel part 11. In this embodiment, it is also possible that the right-hand end of torsion bar 6 is mounted rotatably on blockable belt reel part 11 and is connected to rotating member 4 via a break point embodied, for example, as a slip clutch. When the torque produced by torsion bar 6 is exceeded, torsion bar 6 rotates relative to the rotating member.

[0023] In the embodiment in Figures 10 and 11, torsion bar 6 is joined at its one end (its left-hand end) to rotatable belt reel part 14, and at its other end torsion bar 6 is joined non-rotatingly to rotating member 4, which is likewise embodied as an impeller. Torsion bar 6 is mounted rotatably in relation to blockable belt reel part 11. In the event of the relative rotational movement of rotating member 4 in relation to the granulate disposed in load limiter chamber 8 being blocked, torsion bar 6 acts solely as a load limiter.

[0024] In the embodiment in Figures 12-14, load limiter chamber 9 and granulate 3 are located in a recess in blockable belt reel part 11. Rotating member 4, which is preferably embodied as an impeller (Figure 3D), is joined non-rotatingly to rotatable belt reel part 14. Rotating member 4 is mounted rotatably in relation to torsion bar 6. When the belt strap is unreeled with load limitation, rotating member 4 rotates together with rotatable belt reel part 14 relative to the blocked belt reel part 11, which contained granulate 3 in load limiter chamber 8. Torsion bar 6, the right-hand end of which is joined non-rotatingly to blocked belt reel part 11, is torsioned simultaneously. This results in an additive limitation effect on the belt strap, as shown in Figures 10 and 11.

[0025] In the embodiment in Figures 8 - 14, a blocking mechanism 16 is shown which in a belt strap-sensitive and/or vehicle-sensitive manner prevents the blockable belt reel part 11 from rotating when excessive acceleration or braking occurs, and which in normal vehicle operation prevents the entire belt reel 1 on frame 7 from rotating. In an accident, as already explained, blockable belt reel part 11 on frame 7 is blocked against rotating and rotatable belt reel part 14 can be rotated when the vehicle passenger wearing the seat belt moves forwards with the belt strap unreeling with load limitation.

[0026] When rotary wheel 4, embodied as an impeller, rotates clockwise relative to granulate 3 in the embodiment shown in Figures 8, 9 and 12 - 14, the granules in load limiter chamber 8 are displaced substantially in the direction of rotation. Load limiter chamber 8 and granulate 3 are located in a cavity at the end face of rotatable belt reel part 14. In the embodiment in Figure 10, when rotating member 4 embodied as an impeller rotates clockwise relative to granulate 3, displacement components acting radially outwardly act on the granules in load limiter chamber 8. The vanes of the impeller shown in the embodiment in Figures 8 - 14 are curved. The vanes may be deformed when the load limiter rotates, with the result that an additional influence on the load limitation effect is achieved by such deformation. The vanes may also have a twist.

[0027] Rotating member 4, in particular a rotating member in the form of an impeller (Figures 3C, 3D and 8 - 11), may be deformable in the radial direction. In particular, the vanes of the impeller may deform radially outwardly when rotating with energy absorption in granulate 3, as a result of which the effective radius increases and stronger shear forces are exerted on the granules, in particular at the circumferential edge of the vanes.

[0028] In the embodiment shown schematically in Figures 1, 2, load limiter 2 is located in a housing which is attached to the belt retractor frame 7 and which is formed by the two housing sections 9 and 10. Rotating member 4 is disposed in load limiter chamber 8, which is enclosed by the two housing sections 9 and 10. Granulate 3, and rotating member 4 exerting the required shear forces on the granules, are located inside load limiter chamber 8. Housing sections 9 and 10 may be fixedly disposed on frame 7, a coupling between the rotatable belt reel part and rotating member 4 being provided between rotor 4 and belt reel 1, said coupling being disengaged during normal operation of the belt retractor and engaged for operation of the load limiter. The rotating member is preferably arranged coaxially with rotational axis 5 of belt reel 1.

[0029] Figure 15 shows a cutaway view of another embodiment. The basic structure of this embodiment is the

same as that in the embodiment in Figures 1 and 2. Load limiter chamber 1 is enclosed, accordingly, in a housing comprising housing sections 9 and 10. Granulate 3 is located in the load limiter chamber. The housing is attached to frame 7. Rotor 4 in load limiter chamber 8 is connected with a coupling to belt reel 1 and to rotatable belt reel part 14. The coupling is disengaged during normal belt retractor operation, so belt reel 1 can rotate freely relative to rotating member 4. For unreeling of the belt strap under load limitation, coupling 23 is engaged, such that rotating member 4 and belt reel 1 or rotatable belt reel part 14 are connected non-rotatingly to each other.

[0030] In this embodiment, the bulk density of the granulate in the load limiter chamber can be adjusted by changing the volume of the load limiter chamber and hence of the granulate 3 with which the load limiter chamber is filled. An adjuster element 20 is provided for this purpose, with which a volume adjuster 21 can be brought into different axial positions in order to change the volume of load limiter chamber 8. Adjuster element 20 may be embodied as a rotatable cam disc which can rotate about rotational axis 5. Depending on the rotation angle position of adjuster element 20, the volume of load limiter chamber 8 and hence the bulk density of granulate 3 is altered by the axial displacement of volume adjuster 21. A servodrive 19, for example an electric motor, which is controlled by a controller 18 may be provided to position the adjuster element 20 in the respective rotation angle position. Said controller may be a separate control unit, or a control unit integrated in the on-board computer of the motor vehicle. In the embodiment shown here, controller 18 is connected to a rotational speed sensor 33. The signal from the rotational speed sensor corresponds to the speed at which the belt strap is unreeled under load limitation from belt reel 1, or more specifically from rotatable belt reel part 14. In controller 18, the respective acceleration and hence an indication of the severity of the accident can be determined, together with the body weight of the vehicle passenger wearing the seat belt. Other key data supplied to controller 18 may include the length of belt unreeled from the parked position of belt reel 1 when putting on the safety belt, the position of the seat in the axial direction of the motor vehicle, the body size and body weight of the vehicle passenger and the acceleration or braking force acting at the position of the vehicle passenger in the vehicle during an accident.

[0031] In the embodiment shown in Figures 4 - 7 and Figures 10 -14, a change in the volume of load limiter chamber 8 can also be produced by a relative displacement, in particular in the axial direction, between blockable belt reel part 11 and rotatable belt reel part 14 within their overlapping region, as shown schematically by a double-headed arrow 22 in Figure 7.

[0032] By means of the invention, the characteristic curves of the load limiter can be adjusted for load-limited extension of the belt strap within a large range in respect of passenger size and weight, and the severity of the accident.

[0033] In the belt retractor shown schematically in Figures 16 - 19, a transmission gear with a varying transmission ratio is disposed between belt reel 1 and in particular between rotatable belt reel part 14 and load limiter 2. In the embodiments, transmission gear 24 is designed in such a way that it has a progressive transmission ratio. This progressive transmission ratio can be achieved by varying the distance of a load transmission point 25, from which the torque of belt reel 1, or more specifically of rotatably belt reel part 14, is transmitted to load limiter 2, from a rotational axis 5, which may coincide with rotational axis 5 of the belt reel, when the belt reel turns with load limitation. The distance may be changed along a spiral path 25 around rotational axis 5. The components of the belt retractor shown in Figures 16 - 19 are suitably mounted on a belt retractor frame which is not shown here in any further detail.

[0034] Spiral 25 may have a conical profile and be arranged on a conically shaped pulley wheel 30. The conically shaped pulley wheel 30 and hence the load transmission point 25 running in spiral cable grooves are connected via a coupling 23 to belt reel 1, or more specifically to rotatable belt reel part 14. Coupling 23 is designed in such a way that, in the event of any relative rotation of reel part 14 in relation to the torsion bar 6 joined non-rotatingly at one end to the blocked belt reel part 11, it is put into the engaged state when there is any belt unreeling movement. This coupling 23 is disengaged during normal belt retractor operation.

[0035] In the embodiments shown, the rotational movement of rotatable belt reel part 14 can be transmitted from the spiral load transmission point 25 to load limiter 2 via load cable 26 when coupling 23 is engaged.

[0036] In the embodiment shown in Figures 16 and 17, load limiter 2 contains a displacer body 28 which is linearly moveable in load limiter chamber 8 and which is disposed like a piston in the granulate 3 in load limiter chamber 8. Load limiter chamber 8 may be attached via attachment point 31 to the belt retractor frame, if necessary pivotably. Displacer body 28 may have axially extending through holes In its displacer body, or axially extending passages at its circumference, through which the granules can pass from one side to the other side of displacer body 28 when displacer body 28 moves.

[0037] In the embodiment shown in Figure 18, load cable 26 is guided around a cable deflection point 27, for example a guide pulley, and connected to a pulley wheel 29 which is provided at the end of torsion bar 6. In this way, the rotational movement of the rotatable belt reel part 14 is transferred via the transmission gear to the rotatable end of torsion bar 6. The other end of torsion bar 6 is fixedly connected to blocked belt reel part 11.

[0038] In the embodiment in Figure 19, rotation of the rotatable belt reel part 14 is transferred via load cable 26 deflected about deflection point 27 to the pulley wheel 29 connected to rotating member 4. Rotating member 4 is a component of load limiter 2, which may be designed as described above with reference to Figures 1 and 2.

According to the invention a belt retractor is shown in Figure 20. The belt reel 1 is rotatably mounted on frame 7. Belt reel 1 consists of blockable belt reel part 11 and belt reel part 14 which is rotatable relative to blocked belt reel part 11. When excessive accelerative or braking forces are exerted, blockable belt reel part 11 is blocked with the aid of blocking mechanism 16, which is embodied in a known form. The blocking mechanism is disposed in housing sections 9 attached to frame 7.

Granulate 3 is disposed in load limiter chamber 8, which is enclosed by blockable belt reel part 11 and by rotatable belt reel part 14. Rotor 4, which may be embodied as an impeller as described in the previous embodiments, is located in the granulate. Rotor 4 sits non-rotatingly on an axial guide 36. Blockable belt reel part 11 is likewise connected non-rotatingly to the axial guide. This can be realised by providing rotor 4 and blockable belt reel part 11 with appropriate inner cross-sections and by providing axial guide 36 with an matching cross-section. This can be achieved, for example, by cross-sections that deviate from a circular shape, for example by oval, polygonal cross-sections, in particular by square cross-sections. Axial guide 36 extends in the axial direction in the middle of belt reel 1 and has a thread 40 in the region of rotatable belt reel part 14. An adjuster element 35, for example in the form of an adjuster nut, has an internal thread which is in thread engagement with the thread 40 (external thread) of rod-shaped axial guide 36. Adjuster element 35 is connected axially displaceably, but nonrotatingly to rotatable belt reel part 14. To this end, rotatable belt reel part 14 may have one or more longitudinal grooves 41 running in the axial direction on an inner circumference. Correspondingly shaped projections on adjuster element 35 engage longitudinally displaceably in said longitudinal grooves 41.

The axial adjusting movement of adjuster element 35 acts via a spring means, for example via a spring assembly 42, which may consist of disc springs, on an actuator member 37. Actuator member 37 closes working chamber 8 from the inner bore in rotatable reel part 14, in which spring assembly 42 is disposed around axial guide 36. Actuator member 37 may be plate-shaped or disc-shaped.

However, it is also possible to produce thread engagement between an inner thread provided on the wall of the inner bore of rotatable belt reel part 14, and on adjuster element 35 an external thread which engages with said inner thread. The axial guide can also be provided in the form of appropriate longitudinal grooves and projections on the inner circumference of adjuster element 35 and on the outer circumference of axial guide 36.

[0039] During normal operation of the belt retractor, the belt reel is rotatably mounted, together with working chamber 8, rotor 4 and axial guide 36, on frame 7. When the blocking mechanism is activated, for example in an accident, blockable belt reel part 11, axial guide 36 and rotor 4 are prevented from rotating. When the belt strap is unreeled, for example by forwards movement of the vehicle passenger wearing the seat belt, rotatable belt reel part 14 is rotated, together with granulate 3 enclosed by it in load limiter chamber 8, in relation to blocked rotor 4. Rotor 4 thus acts as an unmoved displacement element in granulate 3. Due to the thread engagement described above, adjuster element 5 moves along axial guide 36 and acts via spring assembly 42 on actuator member 37. Pressure is exerted as a result on granulate 3 in load limiter chamber 8, due to the reduction in volume, and said pressure is used to adjust the effect of the load limiter when the belt strap is unreeled. This adjustment is performed according to the severity of the accident and/or the passenger data, such as body size and weight, and the seat position of the vehicle passenger wearing the seat belt. This adjustment of the load limiter effect is performed by an adjuster means 34, which is automatically activated when the belt strap is unreeled and which includes the adjuster element 35 guided along axial guide 36 and which applies spring action on actuator member 37. Small adjusting movements of actuator member 37 are sufficient to achieve the desired load limitation over a wide range for vehicle passengers of different sizes and weights, and for different accident severities. These adjusting movements are less than the grain size of the granules in granulate 3.

The embodiment shown in Figure 21 has a construction similar to the embodiment in Figure 15. A piezoactuator 39 is used as the servodrive for actuator member 37. To control the movement of actuator member 37, an electrical voltage formed by controller 18 according to a measurement signal received from measuring device 38 is applied to the piezoactuator. In the embodiment in Figure 15, this causes a reduction in the volume of load limiter chamber 8 and a particular pressure to be exerted as a result on granulate 3 in load limiter chamber 8 in order to change the bulk density of the granulate. Piezoactuator 39 rests against a part of belt retractor frame 7 and is disposed between said frame portion and actuator member 37.

Measuring device 38, which is connected to controller 18, may be configured in such a way that it detects the data of the vehicle passenger wearing the seat belt, in particular the seat position, weight and size. Measuring device 38 can also establish the severity of the accident. To do so, measuring device 38 can determine the speed speed or acceleration with which the belt strap is unreeled. However, measuring device 38 can also detect the braking intensity or acceleration of the vehicle during an accident. Depending on the measurement signals received from measuring device 38, controller 18 sets the voltage applied to piezoactuator 39, and actuator member 37 is adjusted to change the bulk density of granulate 3.

List of reference signs:

[0040]

1	Belt reel
2	Load limiter
3	Granulate
4	Rotating member
5	Rotational axis
6	Torsion bar
7	Frame
8	Load limiter chamber
9, 10	Housing sections
11	Lockable belt reel part
12	Stator
13	Circumferential surfaces
14	Rotatable belt reel part
15	Stub shaft
16	Locking mechanism
17	Break point
18	Controller
19	Servodrive
20	Adjuster element
21	Volume adjuster
22	Double-headed arrow
23	Coupling
24	Transmission gear
25	Load transmission point (spiral)
26	Load cable
27	Cable deflection point
28	Linear moveable body
29	Pulley wheel
30	Conical pulley wheel
31	Attachment point
33	Rotational speed sensor
34	Servomechanism
35	Adjuster element
36	Axial guide
37	Actuator member
38	Measuring device
39	Piezoactuator
40	Thread
41	Longitudinal grooves
42	Spring assembly

Claims

1. A belt retractor comprising a safety belt reel (1) rotatably mounted on a frame and a load limiter (2) which acts on a rotational movement of the belt reel (1) and has adjustable energy consumption, said load limiter having a granulate (3) which is enclosed in a closed load limiter chamber (8) and consists of dry, granular solid, and at least one member (4), the member (4) and the granulate (3) being arranged so that they are rotatable in relation to each other,
characterised in that the bulk density of the granulate (3) in the load limiter chamber (8) can be varied to adjust the energy consumption, and **in that** the member (4) is held fixed in a fixed position and the granulate (3) is rotated in relation to the member (4).

2. The belt retractor according to claim 1,
characterised in that the volume of the load limiter chamber (8) or the pressure exerted on the granulate (3) can be varied in order to adjust the bulk density of the granulate (3) in the load limiter chamber (8).

3. The belt retractor according to claim 1 or 2,
characterised in that an actuator member (21; 37) controlled by the load-limited rotation of the belt reel (1) or of a rotatable belt reel part (14) is formed to exert a change of pressure on the granulate (3) disposed in the load limiter chamber (8), or to alter the volume of the load limiter chamber (8).

4. The belt retractor according to claim 3,
characterised in that the actuator member (37) is driven by the load-limited rotation of the belt reel (1) or of the rotatable belt reel part (14).

5. The belt retractor according to claim 3 or 4,
characterised in that an adjuster means (34; 39) actuated during load-limited rotation of the belt reel (1) or of the rotatable belt reel part (14) adjusts the actuator member (37).

6. The belt retractor according to claim 5, **characterized in that** the adjusting movement is less than the grain size of the granular solid in the granulate (3).

7. The belt retractor according to claim 5 or 6,
characterised in that the adjuster means (34) has an adjuster element (35), which can be adjusted by thread engagement when the belt reel (1) or the rotatable belt reel part (14) rotates under load limitation, and which acts upon the actuator member (37).

8. The belt retractor according to any one of claims 1 to 6,
characterised in that the adjuster means for the actuator member (37) has a piezoactuator (39) which acts upon the actuator member (37).

9. The belt retractor according to any one of claims 1 to 8,
characterised in that the granulate (3) is made of hard grains.

10. The belt retractor according to any one of claims 1 to 9,
characterised in that the at least one member (4) is embodied as an impeller, the vanes of which are curved and dipped into the granulate (3).

11. The belt retractor according to any one of claims 1 to 10,
characterised in that the load limiter chamber (8) is disposed in the rotatable belt reel part (14).

Patentansprüche

1. Gurtaufroller mit einer Gurtspule (1), die drehbar an einem Rahmen gelagert ist, und einem Kraftbegrenzer (2), welcher auf eine rotierende Bewegung der Gurtspule (1) wirkt, und einen einstellbaren Energieverbrauch hat, wobei der Kraftbegrenzer ein Granulat (3) aufweist, welches in einem geschlossenen Kraftbegrenzerraum (8) eingeschlossen ist und aus trockenem, körnigem Feststoff besteht, und wenigstens einem Körper (4), wobei der Körper (4) und das Granulat (3) so angeordnet sind, dass sie relativ zueinander drehbar sind,
dadurch gekennzeichnet, dass die Schüttdichte des Granulats (3) in dem Kraftbegrenzerraum (8) zum Einstellen des Energieverbrauchs variiert werden kann, und dadurch, dass der Körper (4) in einer fixierten Position fixiert gehalten und das Granulat (3) in Bezug auf den Körper (4) rotiert wird.

2. Gurtaufroller nach Anspruch 1,
dadurch gekennzeichnet, dass das Volumen des Kraftbegrenzerraums (8) oder der Druck, der auf das Granulat (3) ausgeübt wird zum Einstellen der Schüttdichte des Granulats (3) in dem Kraftbegrenzerraum (8) variiert werden kann.

3. Gurtaufroller nach Anspruch 1 oder 2,
dadurch gekennzeichnet, dass ein Betätigungsglied (21, 37), welches durch die kraftbegrenzende Rotation der Gurtspule (1) oder von einem drehbaren Gurtspulenteil (14) gesteuert wird, ausgebildet ist zum Ausüben einer Druckänderung auf das Granulat (3), welches in dem Kraftbegrenzerraum (8) angeordnet ist, oder zum Variieren des Volumens des Kraftbegrenzerraums (8).

4. Gurtaufroller nach Anspruch 3,
dadurch gekennzeichnet, dass das Betätigungsglied (37) durch die kraftbegrenzende Rotation der Gurtspule (1) oder des drehbaren Gurtspulenteils (14) angetrieben wird.

5. Gurtaufroller nach Anspruch 3 oder 4,
dadurch gekennzeichnet, dass ein Einstellmittel (34, 39), welches während einer kraftbegrenzenden Rotation der Gurtspule (1) oder des drehbaren Gurtspulenteils (14) betätigt wird, das Betätigungsglied (37) einstellt.

6. Gurtaufroller nach Anspruch 5, **dadurch gekennzeichnet, dass** die einstellende Bewegung geringer ist als die Korngröße des körnigen Feststoffes in dem Granulat (3).

7. Gurtaufroller nach Anspruch 5 oder 6,
dadurch gekennzeichnet, dass die Einstellmittel (34) ein Einstellelement (35) haben, welches durch Schraubeingriff eingestellt werden kann, wenn die Gurtspule (1) oder der drehbare Gurtspulenteil (14) unter Kraftbegrenzung rotiert, und welches auf das Betätigungsglied (37) wirkt.

8. Gurtaufroller nach einem der Ansprüche 1 bis 6,
dadurch gekennzeichnet, dass die Einstellmittel für das Betätigungsglied (37) einen Piezoaktuator (39) haben, welcher auf das Betätigungsglied (37) wirkt.

9. Gurtaufroller nach einem der Ansprüche 1 bis 8,
dadurch gekennzeichnet, dass das Granulat (3) aus körnigem Feststoff gebildet ist.

10. Gurtaufroller nach einem der Ansprüche 1 bis 9,
dadurch gekennzeichnet, dass der wenigstens eine Körper (4) als ein Flügelrad ausgebildet ist, wobei dessen Flügel gekrümmt und in das Granulat (3) eingetaucht sind.

11. Gurtaufroller nach einem der Ansprüche 1 bis 10,
dadurch gekennzeichnet, dass der Kraftbegrenzerraum (8) in dem drehbaren Gurtspulenteil (14) ausgebildet ist.

Revendications

1. Rétracteur de ceinture, comprenant un tambour (1) de ceinture de sécurité monté tournant sur un cadre et un limiteur (2) de charge, qui agit sur un mouvement de rotation du tambour (1) de ceinture et qui a une consommation d'énergie réglable, le limiteur de charge ayant un granulé (3), qui est enfermé dans une chambre (8) fermée de limiteur de charge et qui consiste en un produit solide sec en grain, et au moins un élément (4), l'élément (4) et le granulé (3) étant agencés de manière à pouvoir tourner l'un par rapport à l'autre,
caractérisé en ce que la masse volumique apparente du granulé (3) dans la chambre (8) du limiteur de charge peut être modifiée pour régler la consommation d'énergie et **en ce que** l'élément (4) est maintenu fixé dans une position fixée et le granulé (3) tourne par rapport à l'élément (4).

2. Rétracteur de ceinture suivant la revendication 1,
caractérisé en ce que le volume de la chambre (8) du limiteur de charge ou la pression appliquée au granulé (3) peuvent être modifiés, afin de régler la masse volumique du granulé (3) dans la chambre (8) du limiteur de charge.

3. Rétracteur de ceinture suivant la revendication 1 ou 2,
caractérisé en ce qu'un élément (21; 37) actionneur commandé par la rotation à limitation de charge du

tambour (1) de ceinture ou d'une partie (14) tournante du tambour de ceinture est conformé pour appliquer un changement de pression au granulé (3) disposé dans la chambre (8) du limiteur de charge ou pour modifier le volume de la chambre (8) du limiteur de charge.

4. Rétracteur de ceinture suivant la revendication 3, **caractérisé en ce que** l'élément (37) actionneur est entraîné par la rotation à limitation de charge du tambour (1) de ceinture ou de la partie (14) tournante du tambour de ceinture.

5. Rétracteur de ceinture suivant la revendication 3 ou 4, **caractérisé en ce qu'**un moyen (34; 39) de réglage, actionné pendant la rotation à limitation de charge du tambour (1) de ceinture ou de la partie (14) tournante du tambour de ceinture, règle l'élément (37) actionneur.

6. Rétracteur de ceinture suivant la revendication 5, **caractérisé en ce que** le mouvement de réglage est plus petit que la granulométrie du produit solide en grain dans le granulé (3).

7. Rétracteur de ceinture suivant la revendication 5 ou 6, **caractérisé en ce que** le moyen (34) de réglage a un élément (35) de réglage, qui peut être réglé par engrènement lorsque le tambour (1) de ceinture ou la partie (14) tournante du tambour de ceinture tourne avec limitation de charge, et qui agit sur l'élément (37) actionneur.

8. Rétracteur de ceinture suivant l'une quelconque des revendications 1 à 6, **caractérisé en ce que** le moyen de réglage de l'élément (37) de réglage a un actionneur (39) piézoélectrique, qui agit sur l'élément (37) actionneur.

9. Rétracteur de ceinture suivant l'une quelconque des revendications 1 à 8, **caractérisé en ce que** le granulé (3) est fait de grains durs.

10. Rétracteur de ceinture suivant l'une quelconque des revendications 1 à 9, **caractérisé en ce que** le au moins un élément (4) est incorporé sous la forme d'un impulseur, dont les pales sont incurvées et plongées dans le granulé (3).

11. Rétracteur de ceinture suivant l'une quelconque des revendications 1 à 10, **caractérisé en ce que** la chambre (8) du limiteur de charge est disposée dans la partie (14) tournante du tambour de ceinture.

Fig. 1

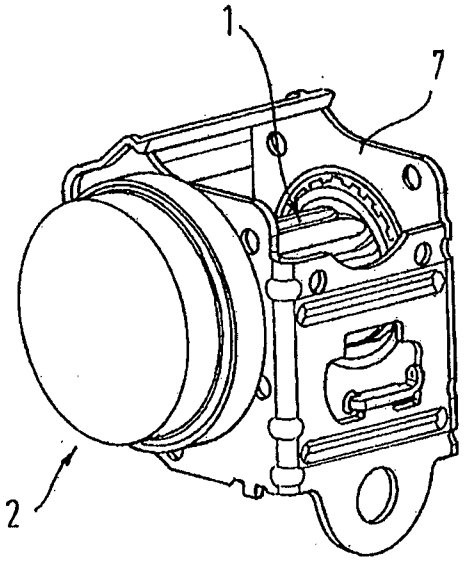


Fig. 2

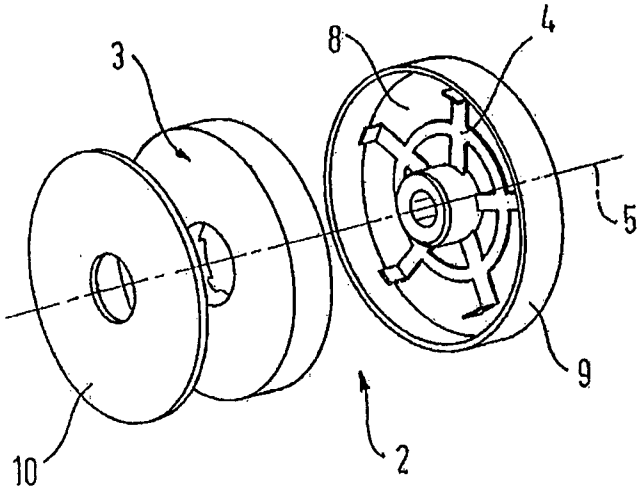


Fig. 3A

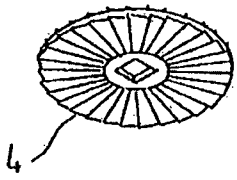


Fig. 3B

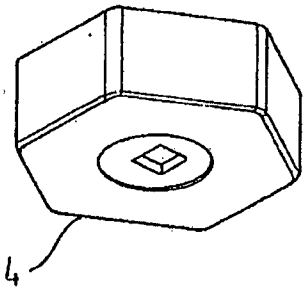


Fig. 3C

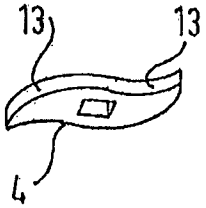


Fig. 3D

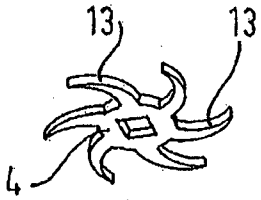


Fig. 4

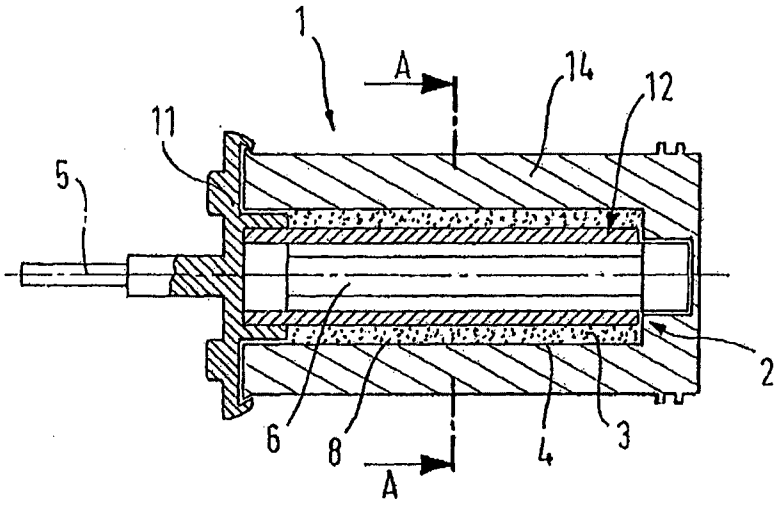


Fig. 5

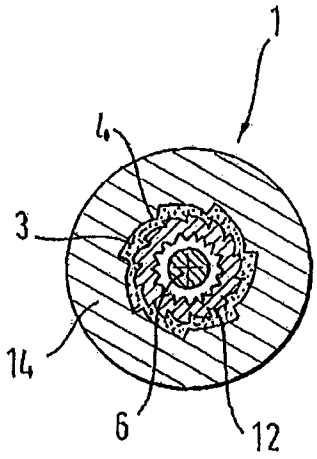


Fig. 6

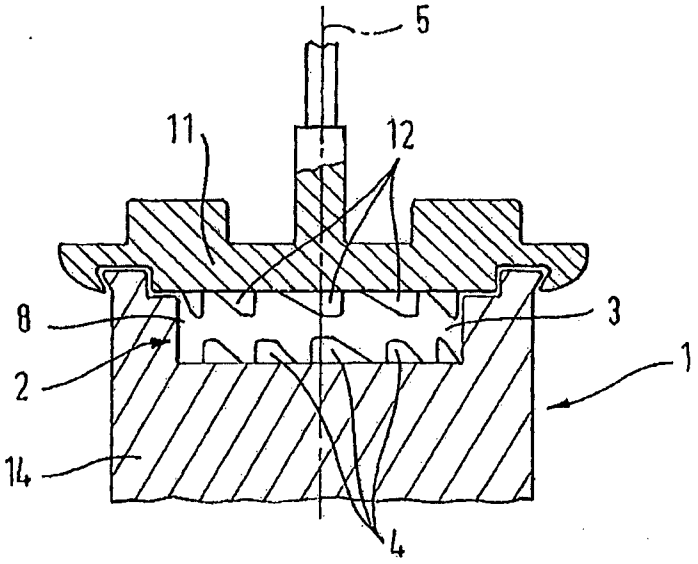


Fig. 7

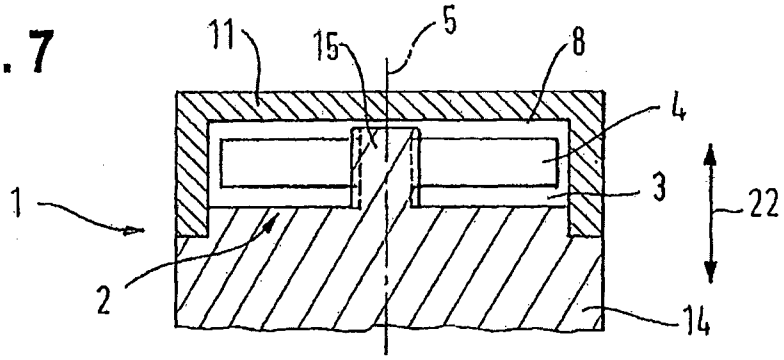


Fig. 9

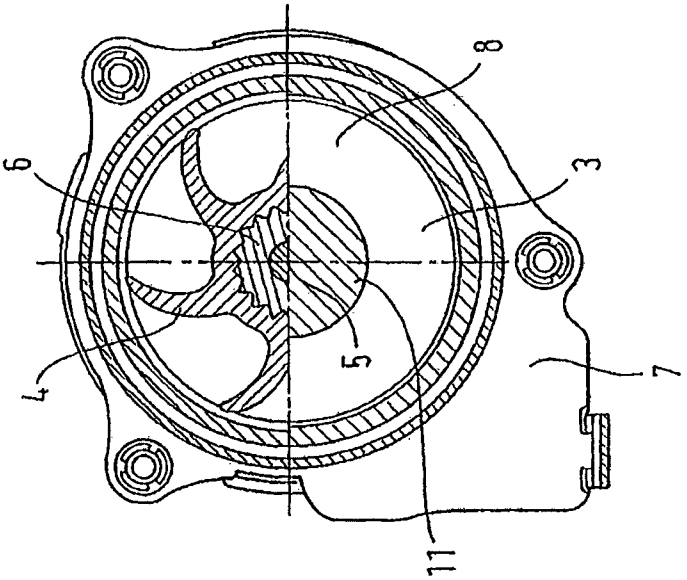


Fig. 8

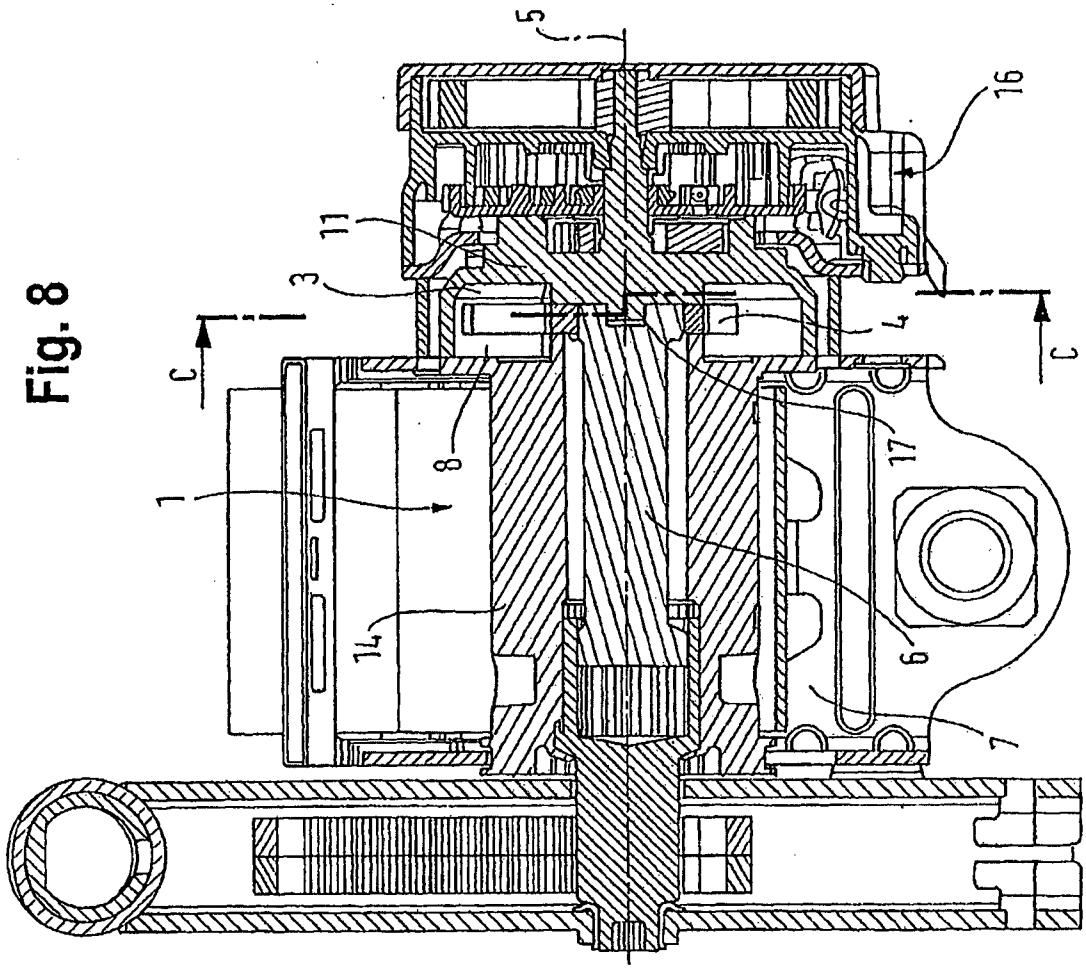


Fig.11

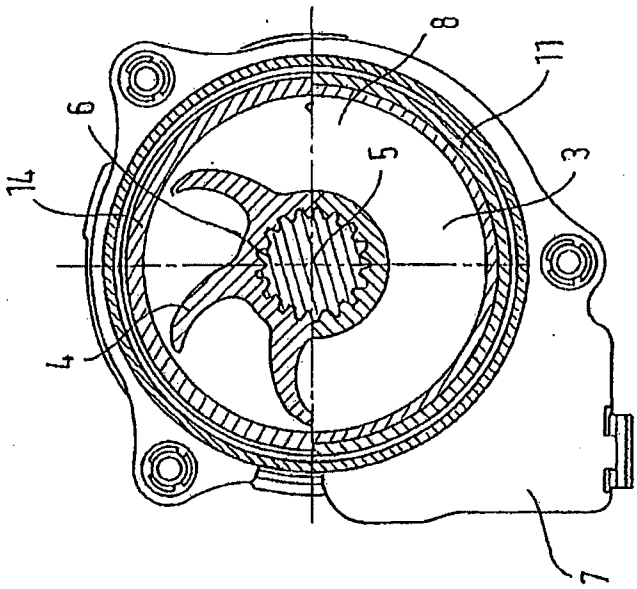
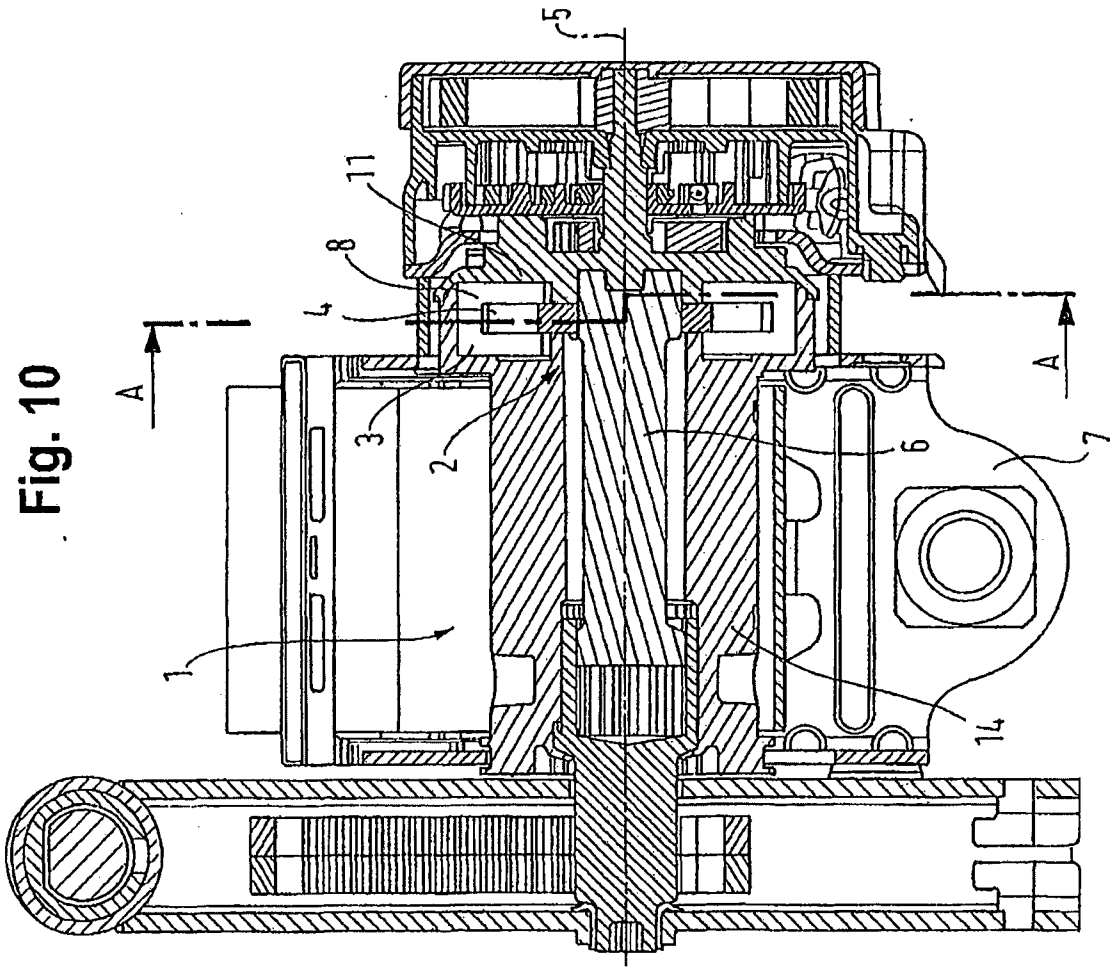


Fig. 10



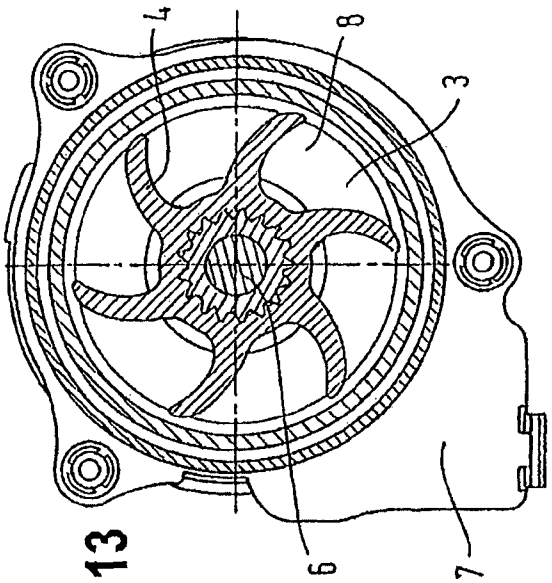


Fig. 13

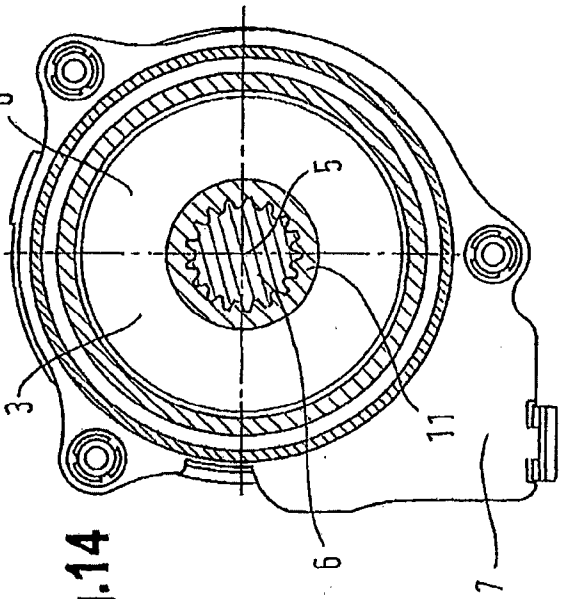


Fig.14

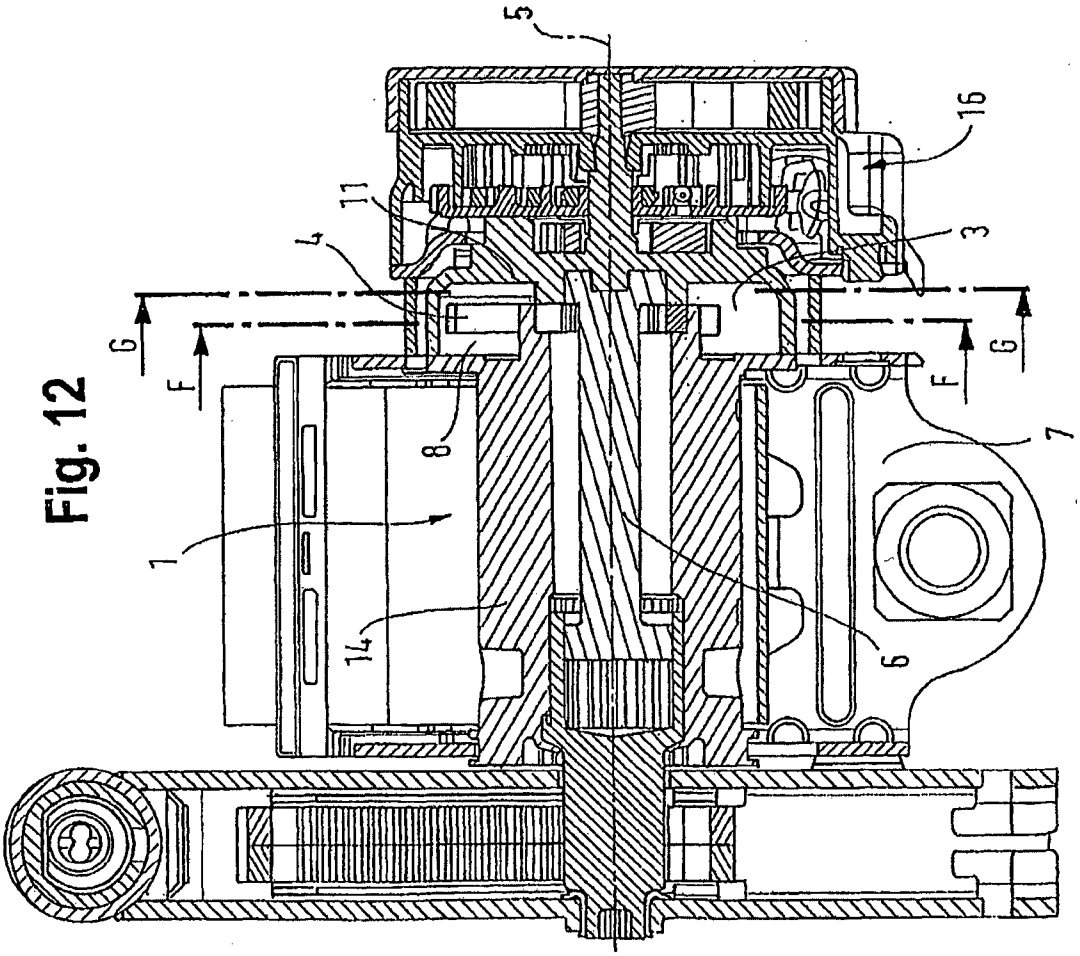


Fig. 12

Fig. 13a

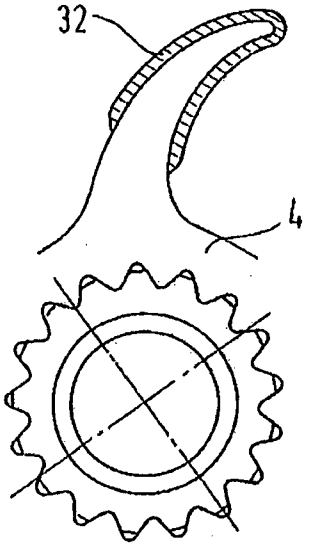


Fig. 15

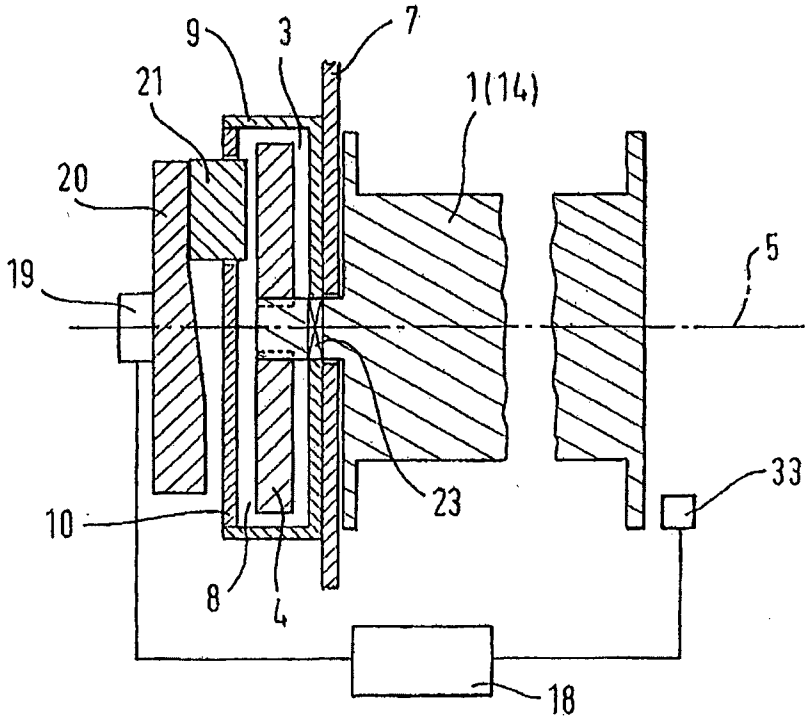


Fig. 16

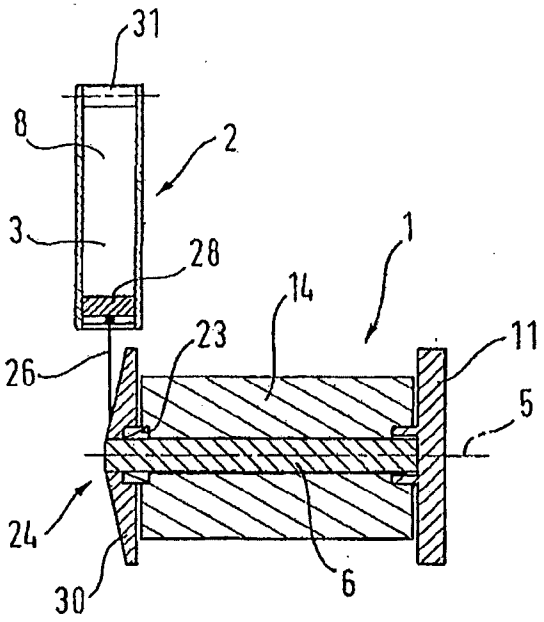


Fig. 17

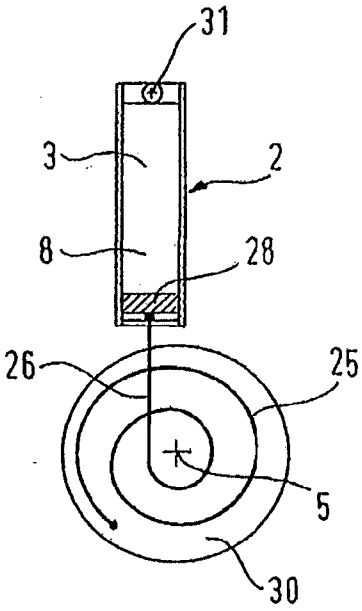


Fig. 18

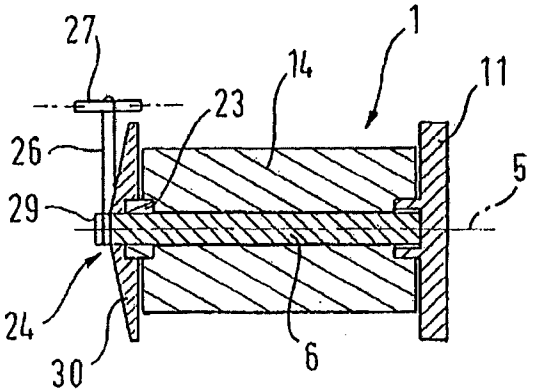
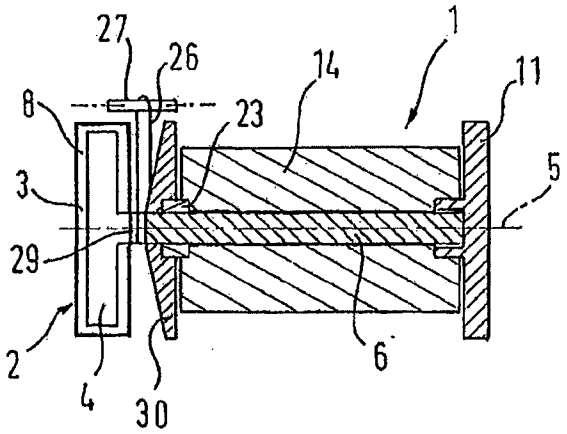


Fig. 19



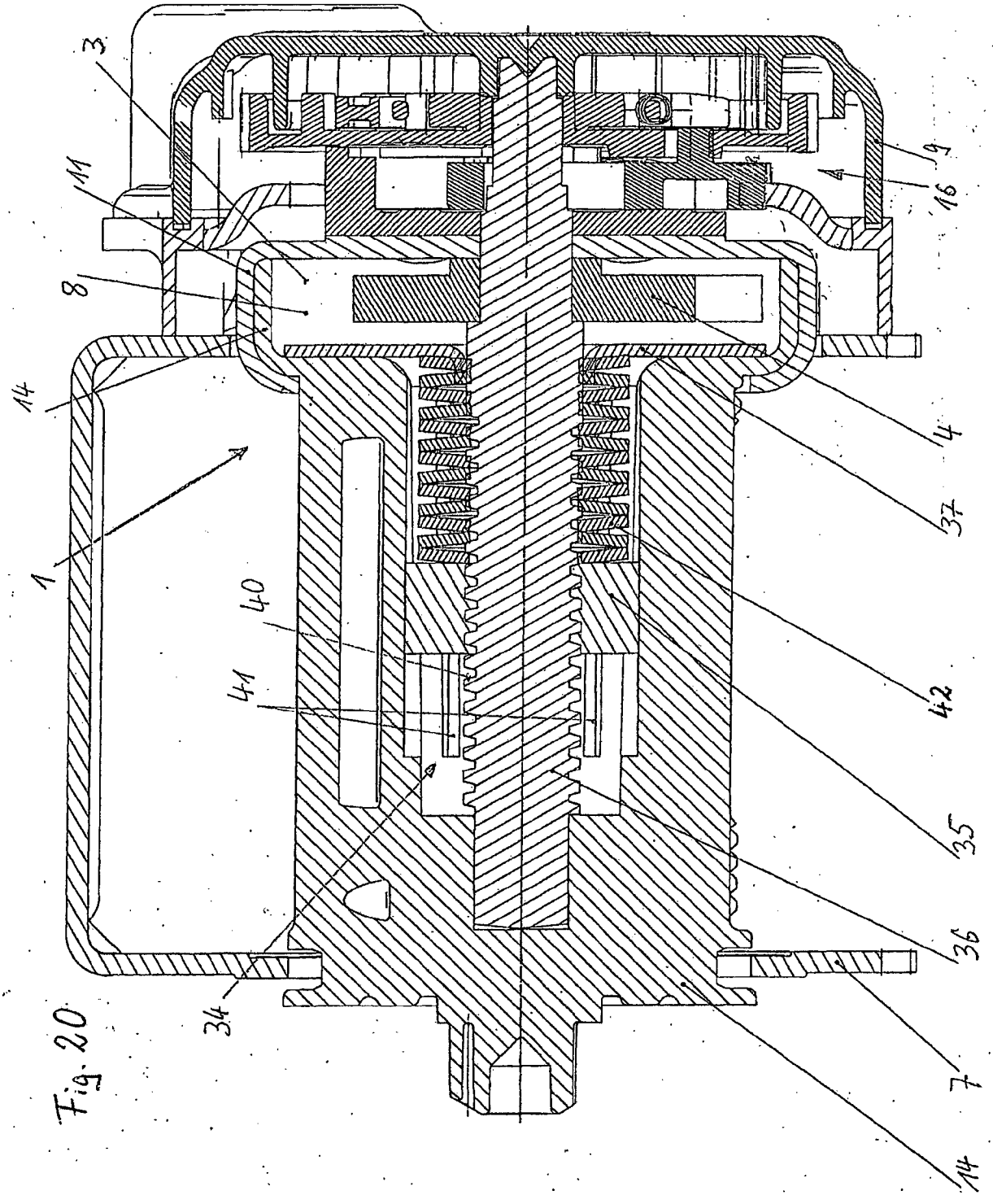
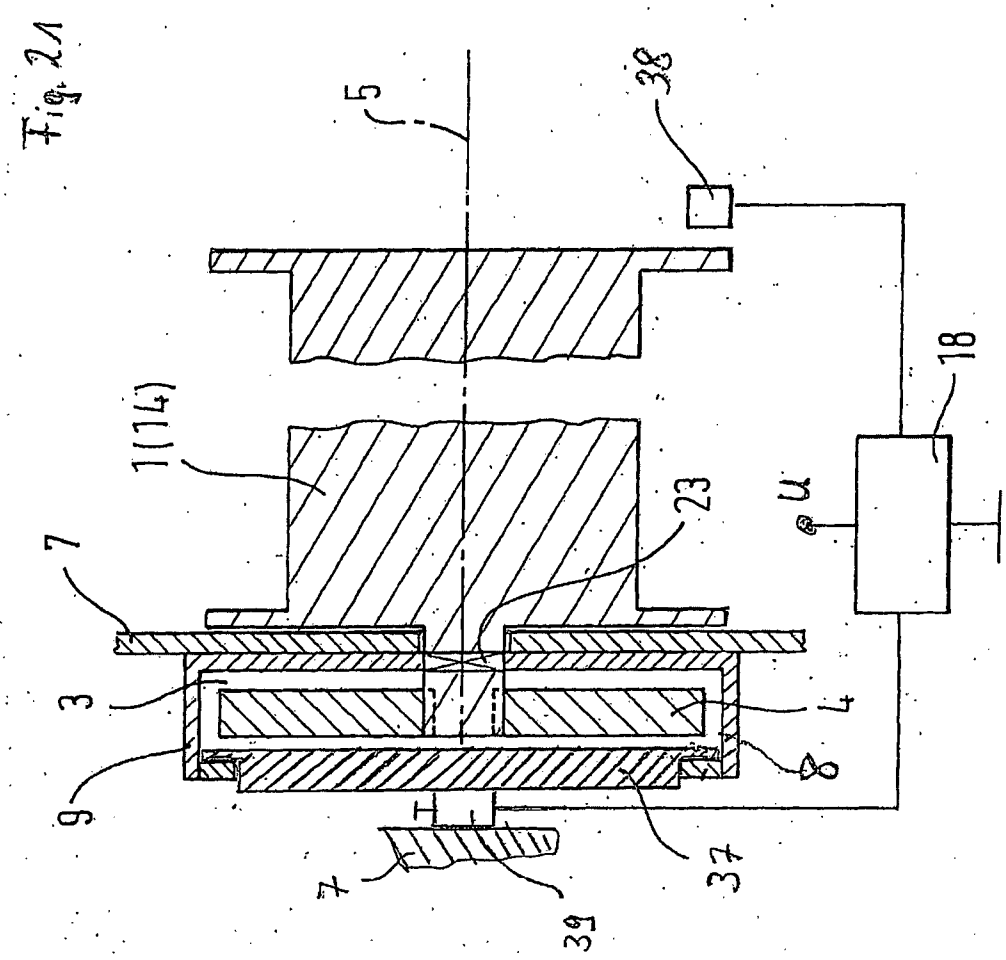


Fig. 20

Fig. 21



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 102009014999 A1 **[0002]**
- WO 2011082757 A **[0003]**

Szabadalmi igénypontok

1. Övfelcsavaró, amely tartalmaz biztonsági öv tekercset (1), amely forgathatóan van szerelve kereten és teherhatárolót (2), amely az öv tekercs (1) forgási mozgására hat és beállítható energiafogasztása van, a teherhatárolónak van granulátuma (3), amely zárt teherhatároló kamrában (8) van bezárva és száraz, szemcsés szilárd anyagból áll, és legalább egy tagot (4), a tag (4) és a granulátum (3) úgy van elrendezve, hogy forgatható kapcsolatban vannak egymással,

azzal jellemezve, hogy a granulátum (3) töltési tömörsége a teherhatároló kamrában (8) változhat az energiafogyasztás beállítására és hogy a tagban (4) van tartva rögzítve egy rögzített pozícióban és a granulátum (3)forgatva van a taghoz (4) képest.

2. Az 1. igénypont szerinti övfelcsavaró,

azzal jellemezve, hogy a teherhatároló kamra (8) térfogata vagy a granulátumra (3) kifejtett nyomás változtatható a granulátum (3) töltési tömörsége beállítására a teherhatároló kamrában (8).

3. Az 1. vagy 2. igénypont szerinti övfelcsavaró,

azzal jellemezve, hogy működtető tag (21; 37), amely az öv tekercs (1) teherbehatárolt forgása vagy forgatható öv tekercs rész (14) által van vezérelve, van kialakítva nyomásváltozás gyakorlására a granulátumra (3), amely a teherhatároló kamrában (8) van elhelyezve, vagy a teherhatároló kamra (8) térfogatának megváltoztatására.

4. A 3. igénypont szerinti övfelcsavaró,azzal jellemezve, hogy a működtető tag (37) az öv tekercsnek (1) vagy a forgatható öv tekercs résznek (14) teherbehatárolt forgása által van meghajtva.

5. A 3. vagy 4. igénypont szerinti övfelcsavaró,

azzal jellemezve, hogy beállító eszköz (34; 39) van működtetve az öv tekercsnek (1) vagy forgatható öv tekercs résznek (14) teherbehatárolt forgása által, amely beállítja a működtető tagot (37).

6. Az 5. igénypont szerinti övfelcsavaró,

azzal jellemezve, hogy beállító mozgás kisebb, mint a granulátum (3) szemcsés szilárd anyagának szemcse mérete.

7. Az 5. vagy 6. igénypont szerinti övfelcsavaró,

azzal jellemezve, hogy a beállító eszköznek (34) van beállító eleme (35), amely beállítható menetkapcsolódással, ha az öv tekercs (1) vagy a forgatható öv tekercs rész (14) forog teherkolátozás alatt és amely a működtető tagra (37) hat.

8. Az 1-6. igénypontok bármelyike szerinti övfelcsavaró,

azzal jellemezve, hogy a beállító eszköznek a működtető taghoz (37) van piezoaktuátora (39), amely a működtető tagra (37) hat.

9. Az 1-8. igénypontok bármelyike szerinti övfelcsavaró

azzal jellemezve, hogy a granulátum (3) kemény szemcsékből van előállítva.

10. Az 1-9. igénypontok bármelyike szerinti övfelcsavaró,

azzal jellemezve, hogy a legalább egy tag (4) járókerékként van kialakítva, amelynek forgólapátjai íveltek és a granulátumba (3) vannak merítve.

11. Az 1-10. igénypontok bármelyike szerinti övfelcsavaró,

azzal jellemezve, hogy a teherhatároló kamra (8) a forgatható öv tekercs részben (14) van elhelyezve.