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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 August 2017 (17.08.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/137016 A1

(51) **International Patent Classification**:
F16F 9/34 (2006.01) ***F16F 9/512*** (2006.01)

(21) **International Application Number**:
PCT/CZ2017/000004

(22) **International Filing Date**:
30 January 2017 (30.01.2017)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
PV 2016-69 11 February 2016 (11.02.2016) CZ

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

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

[Continued on next page]

(54) Title: A METHOD OF CONTROL OF A HYDRAULIC DAMPER DAMPING FORCE AND A HYDRAULIC DAMPER

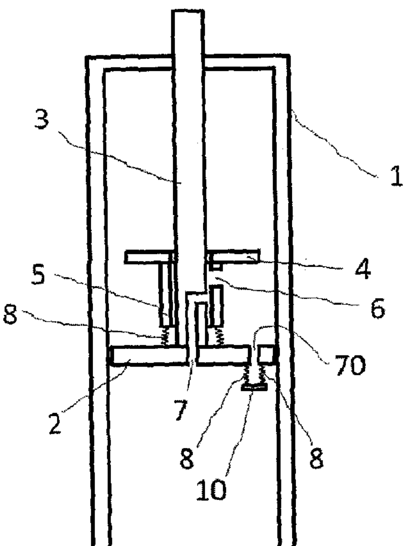


Fig. 2

(57) Abstract: The invention concerns a method of control of a damping force of a hydraulic damper, which comprises a housing filled with a fluid, inside which a piston connected to a piston rod is guided axially, whereas spaces above and under the piston are connected through connecting channels in which fluid flow rate control members are arranged, the subject matter of which lies in a fact that the damper piston velocity is determined at which a connecting hole between the spaces above and under the piston opens, is kept open at a velocity above the determined piston velocity value and after the piston velocity drops below the determined value, the connecting hole closes. A subject matter of a hydraulic damper, which comprises a housing filled with a fluid, inside which a piston connected to a piston rod is guided axially, whereas the spaces above and under the piston are connected through connecting channels in which fluid flow rate control members are arranged, lies in a fact that piston rod (3) of the damper is connected to a control member for opening of connecting hole (7) between the spaces above piston (2) and under piston (2) of the damper.

WO 2017/137016 A1

SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

A method of control of a hydraulic damper damping force and a hydraulic damper

Technical Field of the Invention

The invention concerns a method of control of a damping force of a hydraulic damper which comprises a housing filled with a fluid, inside which a piston connected to a piston rod is guided axially, whereas the spaces above and under the piston are connected through connecting channels in which fluid flow rate control members are arranged.

State-of-the-art

A hydraulic damper, thereinafter a damper, is an important element in a vehicle chassis used both to provide a vibration comfort for passengers and cargo and to ensure a uniform contact of a wheel with a road. However, when a vehicle runs onto a large bump, the damping force increases too much, which represents large impact loading for passengers, cargo and the vehicle bearing structure. Therefore a protection against such a large loading is demanded through degressive damper characteristics, where after exceeding a specific relative velocity the damping force decreases instead of increasing, whereas this is a passive non-controlled damper. Typically, flexibility controlled elements are used in dampers (e.g. DE102005055801B3), causing a drop in the damping force increase, while a relative velocity of a damper movement increases. These characteristics are also called degressive, however, they are degressive only in a slope, not in an absolute value of the damping force, which is insufficient for a protection against shocks. Therefore dampers have been designed (e.g. DE10105098C1, US20050016805A1), which ensure degressive characteristics, but only through an irreversible change of a damper given by tearing its structural elements apart. Another solution is proposed using controlled dampers (e.g. US20040200946A1, US5937975A), however, this requires a more complicated design, a power source and electronics that may be unreliable. A solution for a degressive characteristic of a damper in the absolute value with a reversible behavior based on a passive (non-controlled) damper is still an open problem.

The aim of this invention is to create a solution of a passive damper with a degressive characteristic in the damping force absolute value, where a damping force decreases from a specific value of a relative velocity.

Subject Matter of the Invention

The subject matter of a method of control of a damping force of a hydraulic damper which comprises a housing filled with a fluid, inside which a piston connected to a piston rod is guided axially, whereas the spaces above and under the piston are connected through connecting channels in which fluid flow rate control members are arranged lies in a fact that the damper piston velocity is determined, at which a connecting hole between the spaces above and under the piston opens, is kept open at a velocity above a determined piston velocity value and after the piston velocity drops below the determined value, the connecting hole closes.

A subject matter of a hydraulic damper as described in the invention lies in a fact, that a damper piston rod is connected to a control member for opening a connecting hole between the spaces above and under the damper piston.

A control member is a push-on ring sliding on a piston rod and fitted with winglets, whereas a compression spring is arranged between the push-on ring and the damper piston and a connecting hole passes through the piston rod. The push-on ring is fitted with a straight-through hole, whereas winglets have concave shapes preferably.

Alternatively, a control member is a push-on ring sliding on a piston rod and fitted with winglets, whereas a compression spring is arranged between the push-on ring and the damper piston and a connecting hole passes through the damper piston onto which a rotating sealing plate or a linearly moveable plate or a ball valve is adjoined.

In another alternative a control member is a Pitot tube fixed to the piston rod, whereas a piston arranged in its part in parallel with the piston rod is connected to a compression spring, the other end of which is connected to the damper piston and in the damper piston a connecting hole is arranged onto which a rotating sealing plate or a linearly moveable plate or a ball valve is adjoined.

In another alternative a control member is a parallel damper, comprising a piston rod with a piston firmly fixed to a piston rod of the damper and a space above the piston is connected to a channel in which a piston with a slide-valve fitted with a connecting hole is arranged against a compression spring.

In another alternative a control member is a parallel damper, comprising a piston rod with a piston firmly fixed to a piston rod of the damper, whereas a sliding housing of the parallel damper, spring-mounted on both sides, is connected through a drawbar to a piston arranged against a compression spring connected to a slide-valve fitted with a connecting hole. A diameter of the parallel damper piston is smaller than an inner diameter of a parallel damper housing.

In another alternative a control member is a Watt centrifugal governor, a motion screw of which is a part of a piston rod or is firmly fixed to it, whereas a motion nut is connected through a drawbar to a piston arranged against a compression spring and connected to a slide-valve fitted with a connecting hole. A spring is arranged between the motion nut and the sliding sleeve. A motion screw can possibly have the function of a piston rod.

Overview of Figures in Drawings

Fig. 1 shows a schematic depiction of a desired damping force course,

Fig. 2 shows a schematic depiction of a basic concept of a passive damper with a degressive characteristic,

Fig. 3 shows a spatial view on the concept of a solution of a passive damper with a degressive characteristic as depicted in Fig. 2,

Figs. 4 to 9 show schematic depictions of a solution of a hysteresis element as depicted in Figs. 2 and 3,

Fig. 4 shows a schematic depiction of a variant of the solution depicted in Fig. 3,

Fig. 5 shows a schematic depiction of another variant of the solution depicted in Fig. 3,

Fig. 6 shows a schematic depiction of a possible embodiment of a controlled damper with a parallel damper,

Fig. 7 shows a schematic depiction of another possible embodiment of a controlled damper with an accumulator.

Examples of the Embodiments of the Invention

Fig. 1 shows a schematic depiction of a required course of F damping force of a damper depending on v_{rel} relative velocity of the damper motion. For relative velocity $0 < v_{rel} < v_1$ this is a progressive characteristic, where F damping force increases along with an increase of the relative velocity both in the absolute value and in the slope, thus applies that both the slope of the dependence $dF/dv_{rel} > 0$ is positive and the slope of the dependence increases $d(dF/dv_{rel})/dv_{rel} > 0$. For relative velocity $v_1 < v_{rel} < v_2$ this is a progressive characteristic in the absolute value, where F damping force increases along with an increase of the relative velocity in the absolute value (the slope of the dependence $dF/dv_{rel} > 0$ is positive), and this is a degressive characteristic in the slope, where the slope of the dependence decreases (an increment of the slope $d(dF/dv_{rel})/dv_{rel} < 0$ is negative). For relative velocity $v_2 < v_{rel}$ this is a degressive characteristic in the absolute value, where F damping force decreases, while the relative velocity increases in the absolute value $v_3 > v_2$ and $F_3 < F_2$ (the slope of the dependence $dF/dv_{rel} < 0$ is negative). The hereinafter described structural design of a damper ensures the damping force course for $v > v_2$. Today's standard solutions are applicable for dependences within $<0, v_2>$ interval.

In nowadays conventional dampers, holes in a piston body open for a transfer of hydraulic fluid between spaces above the piston and under the piston and for equalization of pressures. Opening relates to the total pressure in a damper, which also corresponds to a relative velocity of a motion of the damper with closed holes for a transfer of the hydraulic fluid between spaces above and under the piston, but which does not decrease when these holes open for the hydraulic fluid transfer without decreasing in the damper motion relative velocity.

Fig. 2 shows a schematic section of a basic concept of a solution of a degressive damper consisting of housing 1 of a damper, piston 2 of a damper guided by piston rod 3. In the piston body there is a connecting channel 70 arranged for a hydraulic fluid transfer between the spaces above the piston and under the piston and for equalization of pressures, which gets open by the total pressure in the damper acting on linearly moveable plate 10, exceeding the value of forces of compression springs 8. There are more such holes in the damper body and they are arranged for a motion of damper piston 2 upwards and downwards. This is a conventional solution of dampers to reach a demanded characteristic as depicted in Fig. 1 for relative velocity $0 < vrel < v2$. For a more transparent arrangement, these connecting channels

70 and linearly moveable plates 10 are not depicted in next Figs. 3-13 and their presence is assumed only. Winglets 4 attached to push-on ring 5 move along the piston rod; compression spring 8 is arranged between push-on ring 5 and damper piston 2. Straight-through hole 6 is arranged in push-on ring 5 and connecting hole 7 is arranged in piston rod 3, connecting the spaces above and under damper piston 2; its opening serves for a decrease in a damping force above damper piston 2.

The function of the degressive damper as depicted in Fig. 2 is as follows: If relative velocity v_{rel} of damper piston 2 with respect to damper housing 1 increases, then the pressure above damper piston 2 and a damping force increase, too. The dynamic pressure acting on winglets 4 on push-on ring 5 increases as well and overpowers the force of compression spring 8 acting against it. The dynamic pressure of the hydraulic fluid is a pressure caused by its motion against a motion of relatively still areas, in this case winglets 4. A sum of the static and dynamic pressure acts above winglets 4, only the static pressure acts under winglets 4, resulting in only the dynamic pressure acting on winglets. By overpowering the force of compression spring 8 push-on ring 5 gets moving and straight-through hole 6 in push-on ring 5 opens, as well as additional connecting hole 7 between spaces above and under the damper piston 2 opens. Thus the hydraulic fluid starts to flow from the space above piston 2 to the space under damper piston 2 and the pressure acting above piston 2 decreases, as well as F damping force decreases, as depicted in Fig. 1. However, the pressure decrease above the piston does not mean a decrease in the dynamic pressure acting on winglets 4 and opening hole 6 in push-on ring 5 and subsequently opening additional connecting hole 7 in piston rod 3. A return of push-on ring 5 by acting of spring 8, resulting in closing hole 6 in push-on ring and connecting hole 7, occurs only after a decrease in relative velocity v_{rel}, as required in Fig. 1.

Fig. 3 shows a schematic depiction of a section of an alternative concept of a solution of a degressive damper depicted in Fig. 2 without straight-through hole 6 in push-on ring 5. The function of the degressive damper as depicted in Fig. 3 is similar to the embodiment depicted in Fig. 2. Connecting channels 70 and linearly moveable plates 10 for achieving a conventional damper characteristic are not shown here.

Fig. 4 shows a schematic section and Fig. 5 shows a schematic view of a basic concept of a solution of another alternative embodiment of a degressive damper consisting of housing 1 of a damper, piston 2 of a damper guided by piston rod 3. Winglets 4 attached to push-on ring 5 move along the piston rod; compression spring 8 is arranged between push-on ring 5 and damper piston 2. The motion of push-on ring 5 initiates the motion of drawbar 11, which controls rotating sealing plate 9 attached to pin 12 that opens or closes connecting hole 7 in a body of damper piston 2 between the spaces above and under the piston, thus causing a decrease in a damping force when connecting hole 7 opens. Drawbar 11 is attached to push-on ring 5 and rotating sealing plate 9 by rotational joints. A size of connecting hole 7 is such that when opened, a damping force decreases below F_2 value at relative velocities of a motion of damper piston 2 with piston rod 3 with respect to damper housing 1 higher than velocity v_2 depicted in Fig. 1. Fig. 5 apparently shows that winglets 4 can be designed as a simple disk, however, they can be of a more complicated shape and can be divided to more parts.

The function of the degressive damper comes out of the function of the solution in Fig. 2 and Fig. 3. By acting of the dynamic pressure on winglets 4, push-on ring 5 gets moving and turns rotating sealing plate 9 through drawbar 11 and then connecting hole 7 between the spaces above and under piston 2 opens. Thus the hydraulic fluid starts to flow from the space above damper piston 2 to the space under the piston and the pressure acting on damper piston 2 decreases, as well as F damping force decreases, as depicted in Fig. 1. However, closing of connecting hole 7 occurs no sooner than upon a decrease in a relative velocity of a motion of damper piston 2 with respect to damper housing 1 below v_2 value.

Fig. 6 shows a schematic view of another alternative concept of the solution of the degressive damper similar to the solution in Fig. 4 and Fig. 5. In comparison with the solution depicted in Figs. 4 and 5, drawbar 11 acts on linearly moveable plate 10 guided in linear guide 13. Linearly moveable plate 10 opens or closes connecting hole 7 between the spaces above and under damper piston 2, thus causing a decrease in the damping force. The function of a damper derived from the motion of winglets 4 is the same as in Fig. 4 and Fig. 5.

Fig. 7 shows a schematic section of another alternative concept of the solution of the degressive damper similar to the solution from Figs. 4 and 5 using turning of rotating sealing plate 9 for opening and closing of connecting hole 7. Here the motion of push-on ring 5 acts on drawbar 11, thus causing rotating sealing plate 9 attached to swivel pin 12 to turn. Drawbar 11 is attached to push-on ring 5 and to the arm of rotating sealing plate 9 by rotational joints. The function of a damper derived from the motion of winglets 4 is the same as in Fig. 4 and

Fig. 5. Efficiency of the dynamic pressure acting on winglets 4 is enhanced by a concave shape, increasing a resistance of winglets 4 when moving in a fluid.

Fig. 8 shows a schematic section of an alternative concept of the solution of the degressive damper from Fig. 6 using a linear move of linearly moveable plate 10 for opening and closing of connecting hole 7. Here the motion of push-on ring 5 acts on drawbar 15 to move linearly moveable plate 10 fitted in linear guide 13. Drawbar 15 is fixed to push-on ring 5 and to linearly moveable sealing plate 10. The function is the same as in the embodiment in Figs. 4 and 5.

Fig. 9 shows a schematic section of another alternative concept of the solution of the degressive damper. Here the dynamic pressure from the motion of damper piston 2 with piston rod 3 with respect to damper housing 1 is determined using Pitot tube 24. A sum of the static and dynamic pressure in the hydraulic fluid acts on its upper end d and only the static pressure in the hydraulic fluid acts on its bottom side end. Their difference consisting of the dynamic pressure and corresponding to relative velocity v_{rel} from Fig. 1 acts on piston 25 in Pitot tube 24 and causes its motion against the force of spring 8. A motion of piston 25 is transferred to a motion of drawbar 11. In this arrangement, rotating sealing plate 9 from Fig. 7 is replaced by ball valve 14, in which the very functional connecting hole 7 that connects the spaces above and under damper piston 2 is situated. Ball valve 14 is fitted in a body of damper piston 2 and it is rotational. The motion of piston 25 acts on drawbar 11, acting as a driving force to turn ball valve 14 fitted in the body of damper piston 2.

A function of the degressive damper comes out of a function of the solution in Fig. 7. By acting of the dynamic pressure in Pitot tube 24, piston 25 gets moving and turns ball valve 14 through drawbar 11, thus opening connecting hole 7 between the spaces above and under the piston. Thus the hydraulic fluid starts to flow from the space above damper piston 2 to the space under the piston and the pressure acting on damper piston 2 decreases, as well as F damping force decreases, as depicted in Fig. 1. However, closing of connecting hole 7 occurs no sooner than upon a decrease in a relative velocity of a motion of damper piston 2 with respect to damper housing 1 and a decrease in the dynamic pressure in Pitot tube 24.

Fig. 10 shows a schematic section of another alternative concept of the solution of the degressive damper with a parallel damper. An efficient damper consisting of damper housing

1, damper piston 2 and piston rod 3 is shown here. Connecting channels 70 and linearly moveable plates 10 for achieving a conventional damper characteristic are not shown here again. In order to control its damping properties, this damper is fitted with by-pass 17, in which at least one slide-valve 18 is arranged, which is fitted with another connecting hole 7, which connects the spaces above and under damper piston 2, controlled from one side through spring 8 and from the other side through control piston 19. A parallel damper consisting of housing 16 of the parallel damper, piston 21 of the parallel damper, piston rod 22 of the parallel damper is concurrently arranged and attached to the efficient damper with damper housing 1. Piston rod 22 of the parallel damper is controlled concurrently with piston rod 3 of the efficient damper through connecting drawbar 20.

A function of the degressive damper depicted in Fig. 10 is as follows: A motion of piston rod 2 of the efficient damper is transferred through connecting drawbar 20 to parallel piston rod 22 of the parallel damper. Damping force F occurs above piston 21 of the parallel damper depending on a motion of parallel piston rod 22 of the parallel damper, similarly as above piston 2 of the efficient damper. If this force exceeds a value corresponding to relative velocity v_2 depicted in Fig. 1, then the fluid pressure in the parallel damper acting on piston 19 overpowers the force of spring 8 and slide-valve 18 in the by-pass moves, so that connecting hole 7 in by-pass 17 connects the spaces above and under piston 2 of the efficient damper. Thus the hydraulic fluid starts to flow from the space above damper piston 2 to the space under the piston and the pressure acting on damper piston 2 decreases, as well as F damping force decreases, as depicted in Fig. 1. However, closing of connecting hole 7 occurs no sooner than upon a decrease in a relative velocity of a motion of piston 21 with respect to housing 16 of the parallel damper, which is congruent with a relative velocity of a motion of piston 2 with respect to housing 1 of the efficient damper, and upon a decrease in the pressure above piston 21 in the parallel damper and thus a decrease in the pressure on piston 19. So opening and closing of connecting hole 7 only relates to relative velocity v_{rel} of the efficient and parallel damper and not to a pressure ratio above and under damper piston 2, as in today's conventional dampers.

Fig. 11 shows a schematic section of another alternative concept of the solution of the degressive damper with a parallel damper similar to the embodiment as depicted in Fig. 10. An efficient damper consisting of damper housing 1, damper piston 2 and piston rod 3 is shown here. In order to control its damping properties, this damper is fitted with by-pass 17, in which at least one slide-valve 18 is arranged in the by-pass, which is fitted with connecting hole 7 that connects the spaces above and under damper piston 2 controlled from one side through spring 8 and from the other side through control piston 19. A parallel damper consisting of housing 16, piston 21 of the parallel damper and piston rod 22 of the parallel damper is concurrently arranged alongside the efficient damper with damper housing 1. Piston rod 22 of the parallel damper is controlled concurrently with piston rod 2 of the efficient damper through connecting drawbar 20. The parallel damper is attached to the efficient damper through attaching springs 23. The parallel damper is connected to control piston 19 through drawbar 11, which is connected to housing 16 of the parallel damper and to piston 19 through joints.

A function of the degressive damper depicted in Fig. 11 is as follows: A motion of piston rod 2 of the efficient damper is transferred through connecting drawbar 20 to parallel piston rod 22 of the parallel damper. Damping force F occurs above piston 21 of the parallel damper depending on a motion of parallel piston rod 22 of the parallel damper, similarly as above piston 2 of the efficient damper. If this force exceeds a value corresponding to relative velocity v_2 depicted in Fig. 1, then the damping force occurring in the parallel damper overpowers the force of attaching spring 23 and drawbar 11 controlling the motion of piston 19 moves, as well as slide-valve 18 in by-pass 17 moves, so that connecting hole 7 in by-pass 17 connects the spaces above and under piston 2 of the efficient damper. Thus the hydraulic fluid starts to flow from the space above damper piston 2 to the space under the piston and the pressure acting on damper piston 2 decreases, as well as F damping force decreases, as depicted in Fig. 1. However, closing of connecting hole 7 occurs no sooner than upon a decrease in a relative velocity of a motion of piston 21 of the parallel damper with respect to housing 16 of the parallel damper, which is congruent with a relative velocity of a motion of piston 2 with respect to housing 1 of the efficient damper, and upon a decrease in the pressure above piston 21 in the parallel damper and thus a decrease in the damping force in the parallel damper acting on attaching springs 23. So opening and closing of connecting hole 7 only relates to relative velocity v_{rel} of the efficient and parallel damper and not to a pressure ratio above and under damper piston 2, as in today's conventional dampers.

Fig. 12 shows a schematic section of another alternative concept of the solution of the degressive damper with Watt centrifugal governor 26. An efficient damper consisting of damper housing 1, damper piston 2 and piston rod 3 is shown here. In order to control its damping properties, this damper is fitted with by-pass 17, in which at least one slide-valve 18 is arranged in the by-pass fitted with connecting hole 7 that connects the spaces above and under damper piston 2 controlled from one side through spring 8 and from the other side through drawbar 11. Watt centrifugal governor 26 consisting of weights on arms, motion screw 27, motion nut 28, sliding sleeve 29 is concurrently arranged and attached to the efficient damper with damper housing 1. Motion screw 27 of the Watt centrifugal governor is controlled concurrently with piston rod 2 of the efficient damper through connecting drawbar 20.

A function of the degressive damper depicted in Fig. 12 is as follows: The motion of piston rod 2 of the efficient damper is transferred through connecting drawbar 20 to the motion of motion screw 27 of the Watt centrifugal governor and from it through motion nut 28 to the rotational motion of arms and weights of Watt centrifugal governor 26. By the centrifugal force the weights move away from a rotation axis determined by motion screw 27, which is enabled using sliding sleeve 29 on motion screw 27. If the relative velocity of the motion of damper piston 2 with respect to damper housing 1 reaches relative velocity v_2 as depicted in Fig. 1, then an angular velocity of motion screw 27 and a centrifugal force acting on the weights of Watt centrifugal governor 26 is such that the motion and the force of drawbar 11 overpowers the force of spring 8 and slide-valve 18 in the by-pass moves, then connecting hole 7 in by-pass 17 connects the spaces above and below piston 2 of the efficient damper. Thus the hydraulic fluid starts to flow from the space above damper piston 2 to the space under the piston and the pressure acting on damper piston 2 decreases, as well as F damping force decreases, as depicted in Fig. 1. However, closing of connecting hole 7 occurs no sooner than upon a decrease in the angular velocity of motion screw 27, which derives from the relative velocity of the motion of piston 2 with respect to housing 1 of the efficient damper. Weights of Watt centrifugal governor 26 return back to their original position by acting of gravity. Opening and closing of connecting hole 7 only relates to relative velocity v_{rel} of the efficient and parallel damper and not to a pressure ratio above and under damper piston 2, as in today's conventional dampers.

Fig. 13 shows a schematic section of another alternative concept of the solution of the degressive damper with Watt centrifugal governor similar to the embodiment depicted in Fig 12. Here piston rod 3 is designed as motion screw 27. Spring 30 is arranged between motion nut 28 and sliding sleeve 29; the spring substitutes acting of gravity for weights of Watt centrifugal governor 26 in cases, when the motion screw is not in a vertical position.

All the mentioned embodiments refer to characteristic as depicted in Fig. 1, where the positive relative velocity $v_{rel} > 0$, so the upward motion of piston 2 with respect to damper housing 1 is performed. The solution of the characteristic as depicted in Fig. 1 for the negative relative velocity $v_{rel} < 0$, so for the downward motion of piston 2 with respect to damper housing 1, require the use of other elements 5, 9, 10, 14, 18 for opening and closing of similar connecting holes 7 with appropriate plates, but in an inverse arrangement.

All the mentioned solutions and their parts can be combined. For example, all mechanisms for opening of connecting hole 7 controlled by winglets 4 can be used with Pitot tube 24 and vice versa. Or, for example, spring 30 in Fig. 13 can be used for the concept in Fig. 12.

Patent Claims

1. A method of control of a damping force of a hydraulic damper which comprises a housing filled with a fluid, inside which a piston connected to a piston rod is guided axially, whereas the spaces above and under the piston are connected through connecting channels in which fluid flow rate control members are arranged, characterized in that a damper piston velocity is determined at which a connecting hole between the spaces above and under the piston opens, is kept open at a velocity above the determined piston velocity value and after the piston velocity drops below the determined value, the connecting hole closes.

2. A hydraulic damper which comprises a housing filled with a fluid, inside which a piston connected to a piston rod is guided axially, whereas the spaces above and under the piston are connected through connecting channels in which fluid flow rate control members are arranged, characterized in that piston rod (3) of the damper is connected to a control member for opening of connecting hole (7) between the spaces above piston (2) and under piston (2) of the damper.

3. The hydraulic damper as described in Claim 2, characterized in that a control member is a push-on ring (5) sliding on a piston rod (3) and fitted with winglets (4), whereas compression spring (8) is arranged between the push-on ring (5) and damper piston (2) and connecting hole (7) passes through piston rod (3).

4. The hydraulic damper as described in Claim 3, characterized in that push-on ring (5) is fitted with straight-through hole (6).

5. The hydraulic damper as described in Claim 3 or 4, characterized in that winglets (4) have a concave shape.

6. The hydraulic damper as described in Claim 2, characterized in that a control member is push-on ring (5) sliding on piston rod (3) and fitted with winglets (4), whereas compression spring (8) is arranged between push-on ring (5) and damper piston (2) and in damper piston (2) connecting hole (7) is arranged, to which rotating sealing plate (9) or linearly moveable plate (10) or ball valve (14) is adjoined.

7. The hydraulic damper as described in Claim 2, characterized in that a control member is Pitot tube (24) fixed to piston rod (3), whereas piston (25) arranged in its part in parallel with piston rod (3) is connected to a compression spring (8), the other end of which is connected to damper piston (2) and in damper piston (2) connecting hole is arranged (7), to which rotating sealing plate (9) or linearly moveable plate (10) or ball valve (14) is adjoined.

8. The hydraulic damper as described in Claim 2, characterized in that a control member is a parallel damper, comprising piston rod (22) with piston (21) firmly fixed to piston rod (3) of the damper and a space above piston (21) is connected to a channel in which piston (19) with slide-valve (18) fitted with connecting hole (7) is arranged against compression spring (8).

9. The hydraulic damper as described in Claim 2, characterized in that a control member is a parallel damper comprising piston rod (22) with piston (21) firmly fixed to piston rod (3) of the damper, whereas sliding housing (16) of the parallel damper, mounted on both sides with attaching springs (23), is connected through drawbar (11) to piston (19) arranged against compression spring (8) connected to slide-valve (18) fitted with connecting hole (7).

10. The hydraulic damper as described in Claim 8, characterized in that a diameter of piston (21) is smaller than the inner diameter of housing (16) of the parallel damper.

11. The hydraulic damper as described in Claim 2, characterized in that a control member is Watt centrifugal governor (26), motion screw (27) of which is a part of piston rod (3) or is firmly fixed to it, whereas motion nut (29) is connected through drawbar (11) to piston (19) arranged against compression spring (8) connected to slide-valve (18) fitted with connecting hole (7).

12. The hydraulic damper as described in Claim 11, characterized in that spring (30) is arranged between motion nut (28) and sliding sleeve (29).

13. The hydraulic damper as described in Claim 11, characterized in that piston rod (3) is designed as motion screw (27).

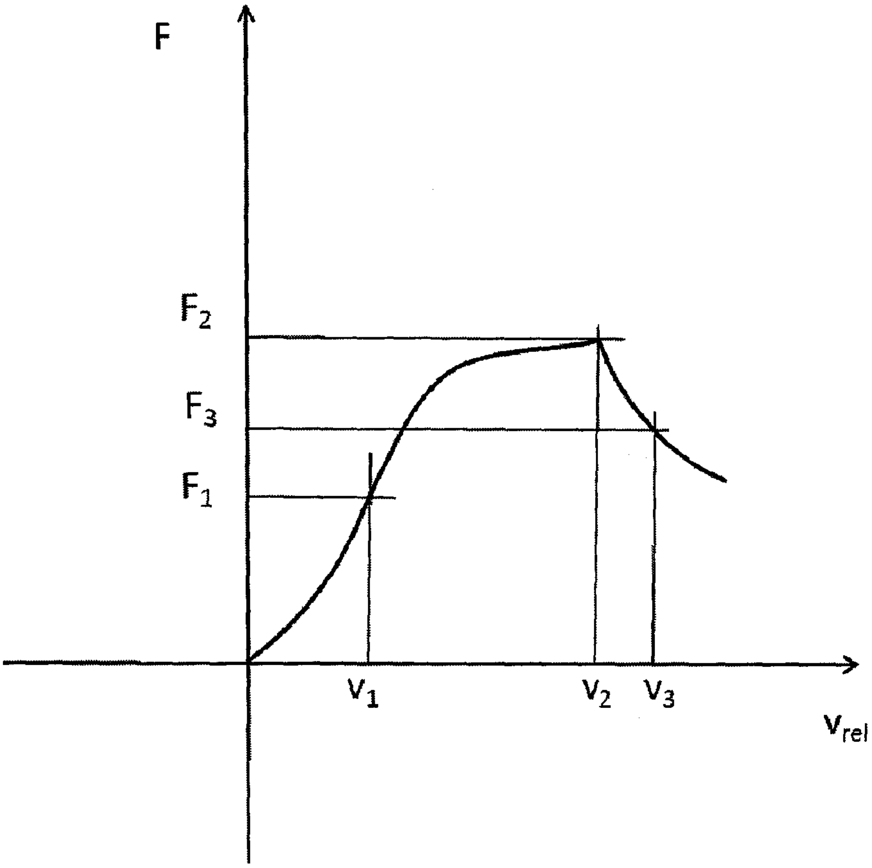


Fig. 1

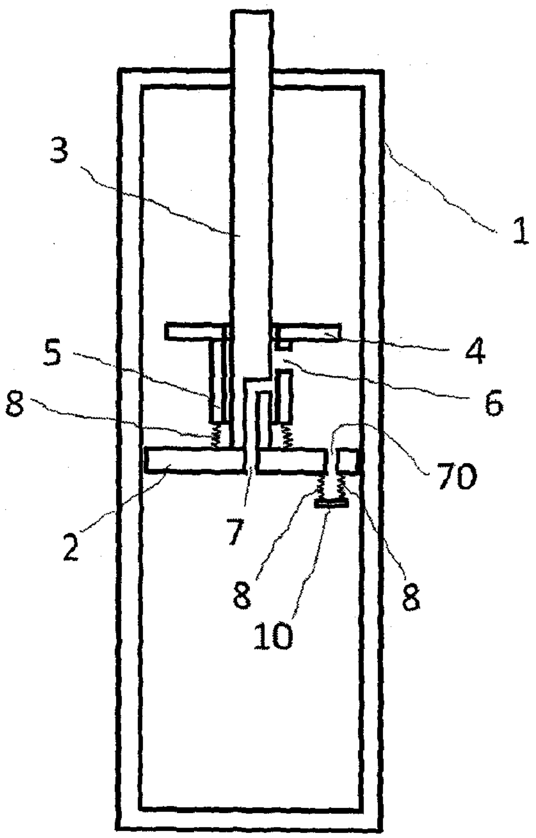


Fig. 2

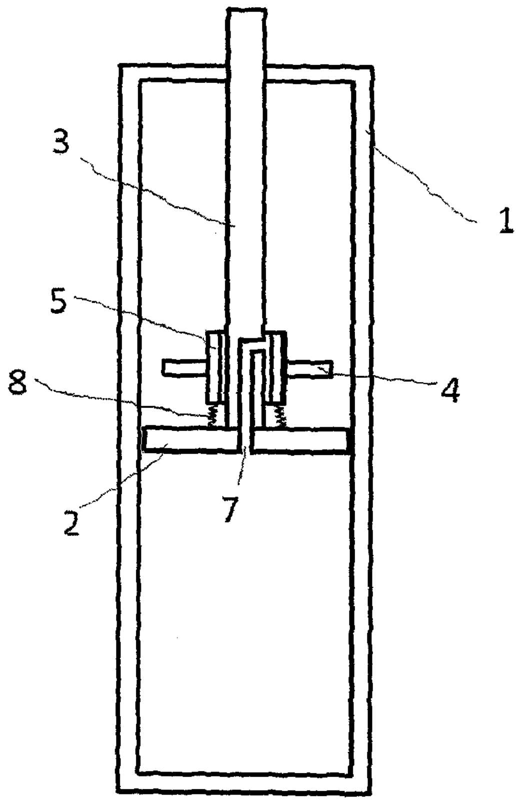


Fig. 3

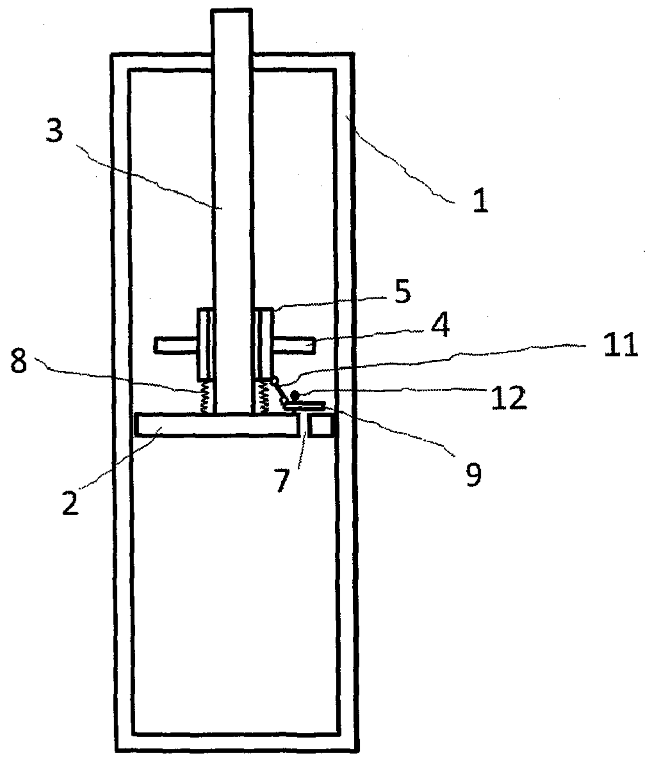


FIg. 4

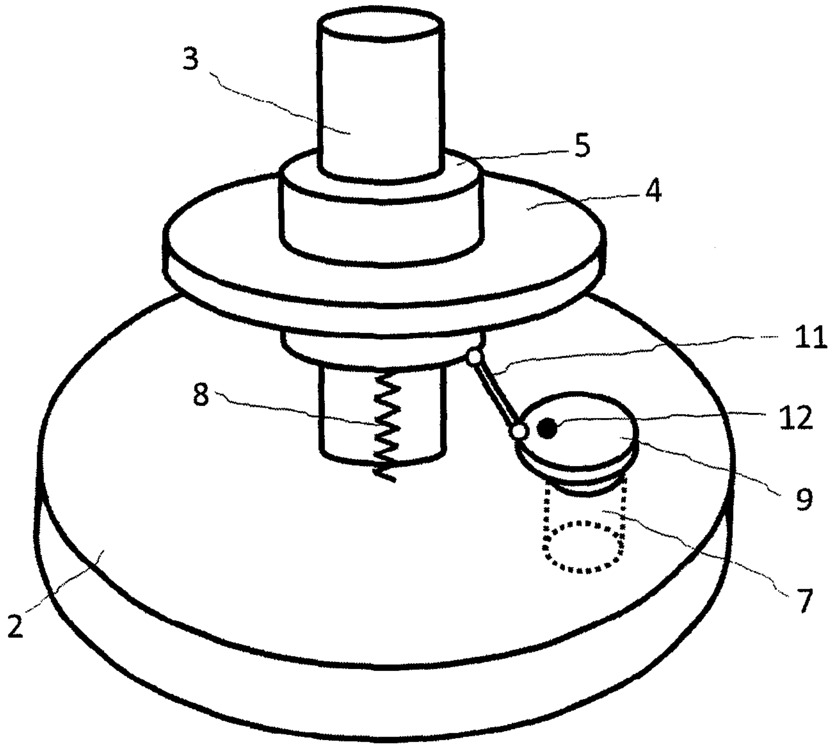


Fig. 5

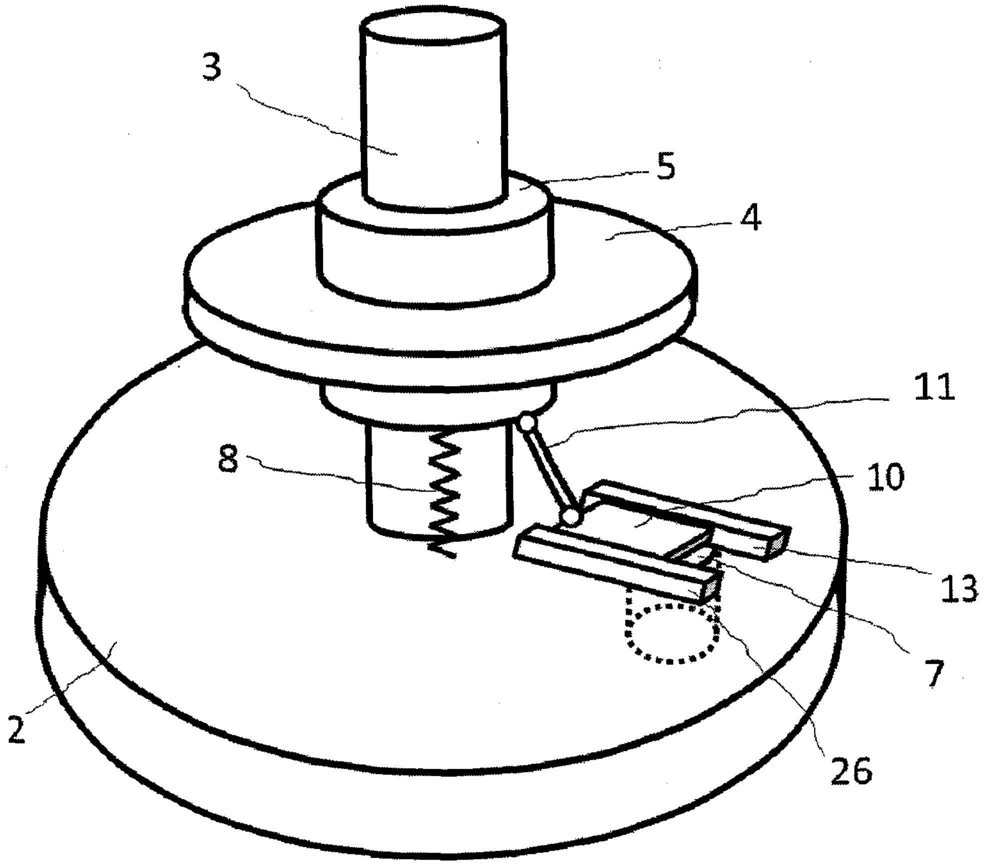
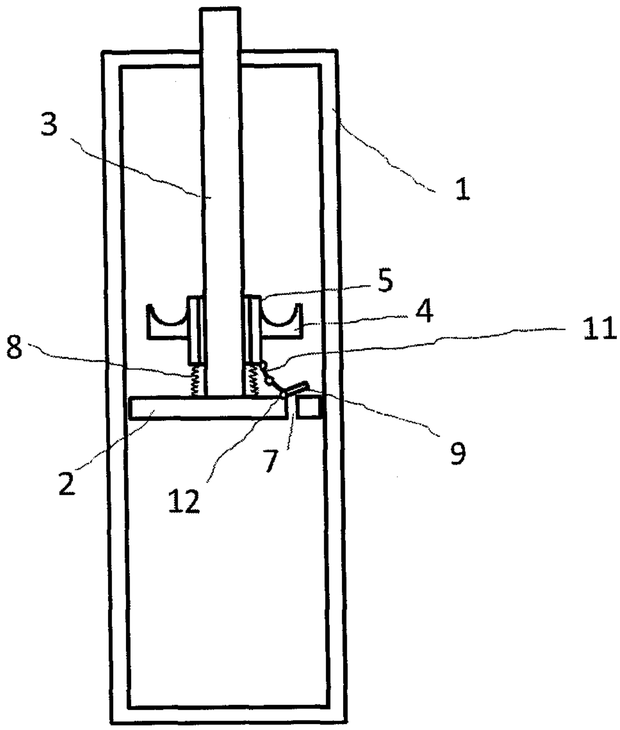


Fig. 6



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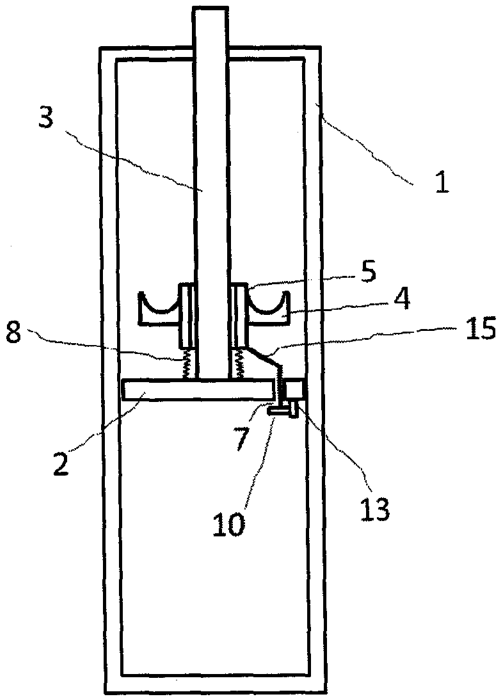
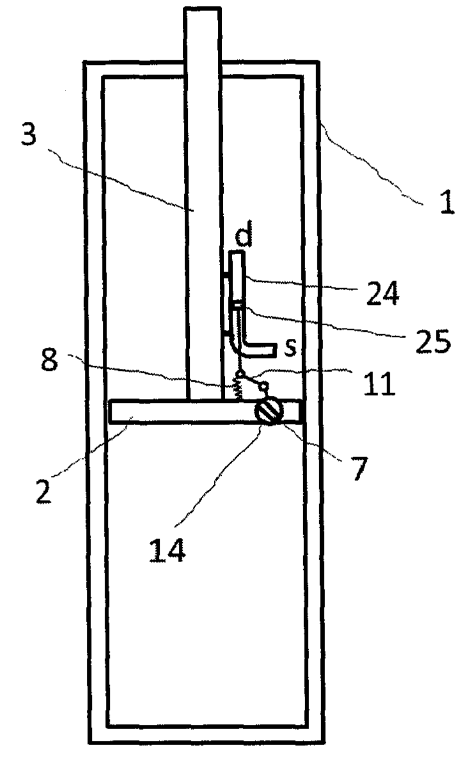


Fig. 8



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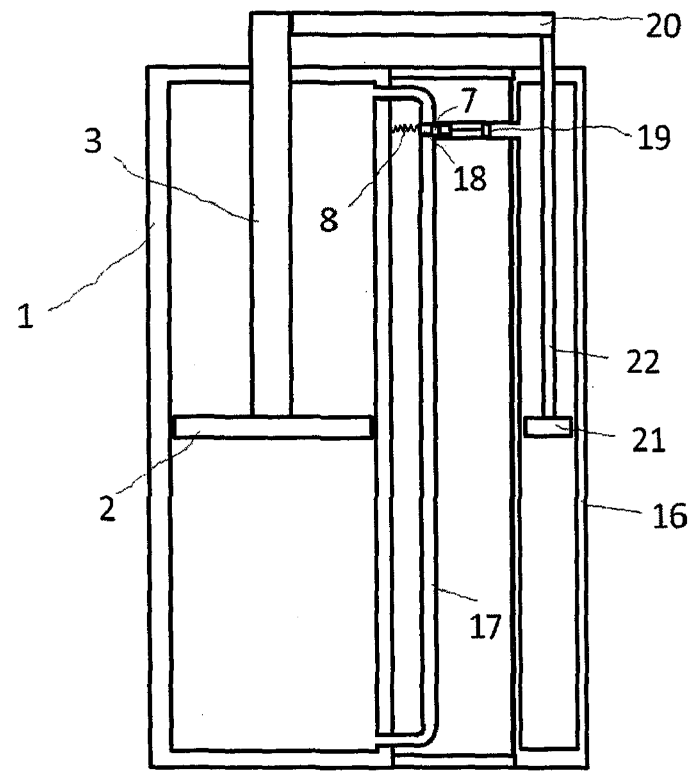

Fig. 10

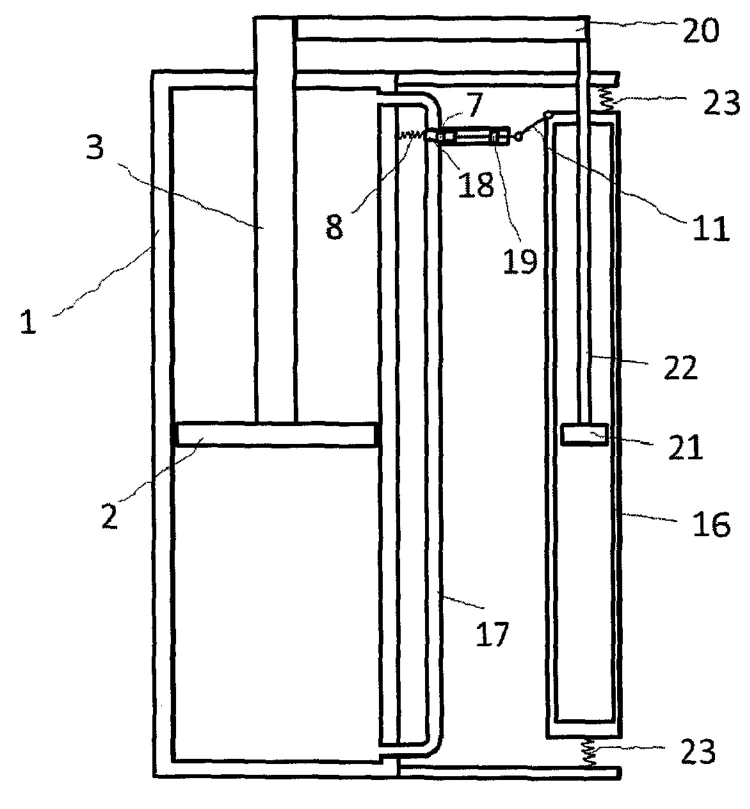

FIg. 11

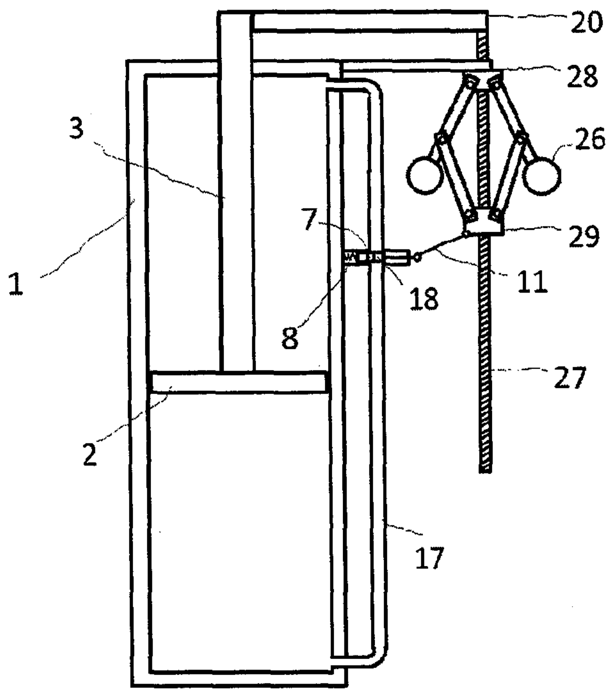

FIg. 12

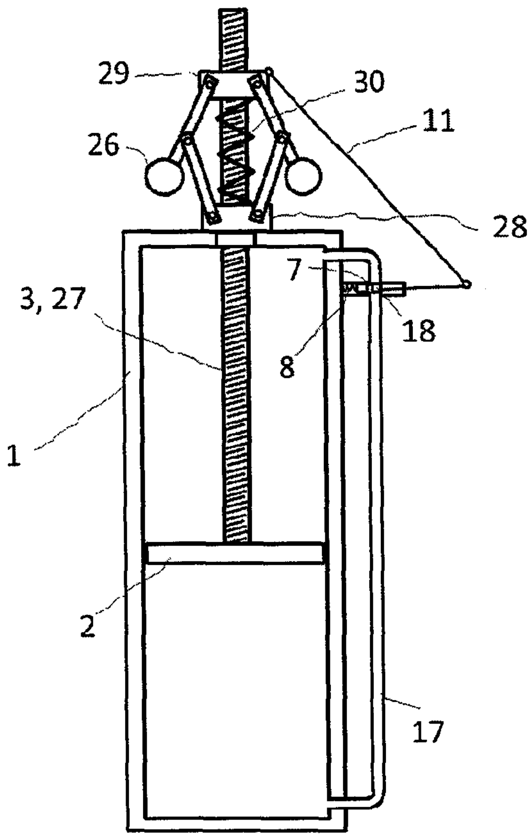

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2017/000004

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16F9/34 F16F9/512
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16F

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2008 008268 A1 (STABILUS GMBH [DE]) 13 August 2009 (2009-08-13)	1-5
A	figures 1,3	7-13
X	DE 10 2010 031144 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]) 12 January 2012 (2012-01-12) figure	1,6
A	EP 0 264 324 A1 (PEUGEOT [FR]; CITROEN SA [FR]) 20 April 1988 (1988-04-20) figure 1	1

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

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 April 2017	20/04/2017

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

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2017/000004

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