

DAMPING DEVICE WITH POWER-ASSISTED DECELERATION AND USE
THEREOF FOR THE DAMPING OF THE RETRACTABLE STEERING COLUMN
OF A MOTOR VEHICLE

The present invention relates to a damping device with power-assisted
5 deceleration, for use in the field of the hydraulic shock absorbers.

The hydraulic shock absorbers presently well-known allow controlling the
stopping of an impacted object through causing a nearly constant deceleration of the
latter. However, for a given design and size of the shock absorber, the level of
deceleration varies according to the mass of said object, as well as according to its
10 speed of impact.

Depending on the field of application involved, this feature can constitute a
limit for the implementation of such a damping device.

This is the case, not restrictively, in the field of the elevators, the anti-collision
systems, car building and namely as regards the steering columns.

15 Indeed, it is known that the steering wheel is a traumatizing obstacle for the
driver in the event of a car accident. In order to improve the driver's safety, the car
manufacturers have positioned an inflatable bag or "air bag" capable, in the event of
frontal accident, of unfolding and intercalating itself between the steer wheel and the
driver.

20 Some car manufacturers are increasingly providing a steering column likely to
be partially withdrawn forwards at the time of the impact, thus allowing freeing a larger
moving distance for the driver. In order to confer a real effectiveness to this concept, it
is necessary for the collapse of the steering column to occur with a controlled force,
which force is generated by the driver striking against the steering wheel via the air
25 bag. This force allows managing the deceleration of the person through controlling his
deceleration.

This deceleration should not be too strong, in order not to be seriously
traumatizing, but neither should it be too slow, for the driver is then not "slowed down"
enough and undergoes a violent impact at the end of the travel distance of the steering
30 column.

The level of deceleration achieved during the collapse of the steering column is
an essential parameter for controlling the non-lethality in the event of a car accident.

The car manufacturers are manufacturing steering columns which use shock absorbers such as those mentioned above, allowing adapting the dynamics of the column at the time of the accident with a controlled force, which optimizes the use of the travel distance of the column.

5 The deceleration induced by this damping force is however directly related to the mass of the individual striking the steering column : the acceleration is equal to the damping force decreased by the striking mass. Thus, the deceleration of a person of little weight is definitely higher than that of a person of higher weight.

10 Therefore, a steering column which is retracted under a constant force cannot provide the same level of safety for a whole population of different stoutness.

15 The object of the present invention is to cope with the various above-mentioned disadvantages by providing a damping device with power-assisted deceleration allowing achieving a constant or nearly constant deceleration during the impact, irrespective of the mass and the speed of the impacting object, and which finds, non-restrictively, a particular application in the power-control of the dynamics of a retractable steering column.

20 According to the invention, the damping device with power-assisted deceleration, for use in the field of the hydraulic shock absorbers, is of the type comprising a sealed body filled with hydraulic fluid, in which is mounted a piston integral with a rod capable of being moved axially out of said body, said rod and said body being arranged so that a strike against one of them, while the other one is integral with a support, causes the axial displacement of the piston and the compression of said fluid in a chamber, and it is primarily characterized in that it comprises, on the one hand, flow means designed capable of allowing said hydraulic fluid to be released from
25 said chamber and, on the other hand, an element which can move axially inside said body and which is designed capable of forming a check valve for closing said flow means when pushed back in the direction opposite to that of the impact by elastic means, said movable element being designed capable of being subjected to the initial speed of said impact, so that its displacement depends on its mass and on the
30 compressive strength of said elastic means.

In use, the impact results into the displacement of the piston inside the body and the compression of the hydraulic fluid in the compression chamber, the initial speed of

the impact is also communicated to the element forming a check valve and, since the latter is connected to the body only through the elastic means, it can, during deceleration, continue its displacement in the direction of the impact by compressing said elastic means, and thus allow a flow out of the chamber. This flow results into
5 reducing deceleration, which causes the check valve to close, and so on.

The operation of the damping device according to the invention is thus in relation with the movement of the check valve, which movement depends only on the mass of the check valve and the compressive strength of the elastic means.

According to an additional feature of the device according to the invention, the
10 piston delimits in the body two chambers, a first compression chamber for the fluid, and a second one for collecting the hydraulic fluid coming from said first chamber and proceeding from an escape provided for at the level of said piston.

The possibility of escaping at the level of the piston allows, during its displacement, a constant or nearly constant deceleration, before the intervention of the
15 movable element forming a check valve.

According to another additional feature of the device according to the invention, the transverse dimensions of the portion of the body which delimits the compression chamber are decreasing in the direction of the displacement of the piston during the compression of said chamber.

20 According to another additional feature of the device according to the invention, the movable element forming a check valve has an annular or similar shape, and is pushed onto or into a part with a globally tubular shape which includes the means for the hydraulic fluid to flow out of the compression chamber, one of its edges being intended to come into contact with a portion of the body which forms the seat of said
25 check valve.

According to another additional feature of the device according to the invention, the edge of the movable element forming a check valve, intended to come into contact with the seat, has on its face opposite that which seals the flow means, a chamfer conferring to said edge a whistle-like profile.

30 According to another additional feature of the device according to the invention, the means for the fluid to flow out of the compression chamber are associated with means allowing transferring the fluid flown out into the second chamber.

According to another particular embodiment of the device according to the invention, the means for the fluid to flow out of the compression chamber are arranged at the level of the piston.

According to a particular embodiment of the device according to the invention,
5 the means for the fluid to flow out of the compression chamber are arranged at the level of the body.

The device according to the invention will advantageously find, but non-restrictively, a particular application in the field of the power-control of the damping of a retractable steering column of a motor vehicle.

10 To this end, according to the invention, the body is integral with the portion of the steering column movable with respect to the vehicle and the rod is integral with the vehicle, so that the displacement of said movable portion causes said rod to be extracted from said body, and the compression by the piston of the compression chamber which is designed capable, according to the position of the movable element
15 with respect to the flow means, of allowing a flow of hydraulic fluid out of said body.

The advantages and the features of the device according to the invention will become clear from the following description, which refers to the attached drawing, which represents several non-restrictive embodiments of same.

In the attached drawing:

20 - figure 1 represents a schematic and longitudinal cross-sectional view of a first embodiment of a damping device with power-assisted deceleration according to the invention.

- figure 2 represents a schematic and longitudinal cross-sectional view of the same device in operation at the time of an impact.

25 - figure 3 represents a schematic and longitudinal cross-sectional view of a variant of this same device.

- figures 4a and 4b represent schematic views of a portion of another variant of the same device.

- figure 5 represents a schematic and longitudinal cross-sectional view of a
30 second embodiment of the same device.

- figure 6 represents a longitudinal cross-sectional view of a third embodiment of the same device, more particularly to be associated with a retractable steering column.

- figures 7a, 7b and 7c represent schematic and longitudinal cross-sectional views of the same device at different phases of its operation.

When referring to figures 1 and 2, one can see a first embodiment 1 of a damping device with power-assisted deceleration according to the invention.

It includes a tubular body 10 closed at its two ends by two flanges 11 and 12, filled with a hydraulic fluid F, and which contains a tubular jacket 13 of reduced transverse dimensions so as to create a peripheral space 14.

The ends of the tubular jacket 13 are formed so as to allow a communication of the peripheral space 14 with the interior of the tubular jacket 13, which, on the side of the flange 11, occurs through radial holes 15.

Through the body 10 axially passes a rod 2 on which is clamped a piston 20 capable of longitudinally evolving in the tubular jacket 13 according to the displacement of the rod 2. The piston 20 divides the tubular jacket 13 into two chambers, a compression chamber or first chamber 16 on the side of the flange 11 and the holes 15, and a second chamber 17 on the other side, more particularly visible in figure 2.

It should be noted that the inner wall 18 of the tubular jacket 13 is not cylindrical, but evolutionary, i.e. its diameter is decreasing, linearly or not, towards the flange 11, so as to create a narrowing. This narrowing generates a hydraulic fluid escape between the piston 20 and the wall 18, escape whose flow rate is decreasing as the piston 20 approaches the flange 11.

Furthermore, the holes 15 are sealed by a sealing system comprising an annular element 3 which forms a check valve, inserted into the tubular jacket 13 on which it is slideably guided, pushed back against the flange 11 forming a seat, by a spring 30 also inserted onto the jacket tubular 13 and clamped onto the latter. The spring 30 is pre-stressed so that, in resting position, the annular element 3 closes the holes 15 and prevents any flow from the first chamber 16 into the peripheral space 14.

With reference in particular to figure 2, one can see that rod 2 is placed into abutment against a support S, while the body 10 is subjected to an impact I, or is integral with an object which is, in turn, subjected to this impact.

Under the impact I, the body 10 moves on the rod 2, and thus, relatively, the piston 20 moves in the tubular jacket 13, so as to compress the hydraulic fluid F in the first chamber 16. The narrowing allows, according to the relative insertion of the piston 20 into the first chamber 16, to gradually limit the flow between the piston 20 and the wall 18, thus to increase the pressure in the first chamber 16 and, hence, to slow down the displacement of the body 2.

This deceleration can be sufficient to cause the element 3 forming a check valve to move on the annular jacket 13 by compressing the spring 30. The displacement of the element 3 forming a check valve results into de-obstructing the holes 15, thus allowing the hydraulic fluid F to pass into the annular space 14 and thereby into the second chamber 17, with the result of a pressure drop in the first chamber 16 and a reduction of the deceleration.

This reduction of the deceleration causes, when it is sufficient, the sealing of the holes 15 by the element 3 forming a check valve, which creates an increase in pressure in the first chamber 16 and, thus, an increase in deceleration, and so on.

One can see that the operation is conditioned by the movement of the element 3 forming a check valve, if the mass of the latter is M and it is maintained by the spring 30 under a pre-stressing R, the movement of the element 3 in the opening direction can occur only under a deceleration of a value higher than the R/M ratio.

It should be noted that, advantageously, the outermost edge of the element 3 forming a check valve, intended to come into contact with the flange 11 forming a seat, has, outwardly, a chamfer 31 conferring it a whistle-like profile, allowing to create a singular pressure loss, which favors the closing of the element 3 forming a check valve.

Furthermore, it should be noted that the shape of the holes 15 is very important, since it can contribute to a modification of the flow characteristics and thus of the power-control. Indeed, during its movement in the direction of opening, the element 3 forming a check valve gradually opens the holes 15 and, according to the shape of the latter, the increase in flow rate is more or less progressive. Moreover, the element 3 forming a check valve opens the holes 15 starting with the portion part of the latter, and

the shape of the latter influences the initial flow rate. Thus, the increase in flow rate is not the same when the holes are round, square, triangular or the like.

The choice of the shape of the holes can thus allow regulating the power-control.

5 When referring now to figure 3, one can see an exemplary construction of the device 1. One recognizes the tubular body 10, two flanges 11 and 12, the tubular jacket 13 and the peripheral space 14, the radial holes 15, the compression chamber 16, the rod 2 and its piston 20, the annular element 3 forming a check valve, and the pre-stressed spring 30.

10 In this mode of construction, the rod 2 only passes through the flange 11, which is associated with a guiding part 110 allowing to carry the rod 2 over a large distance, and which is arranged against the flange 11, on the inner side. In this example, the tubular jacket 13 consists of a tube intercalated between two flanges 11 and 12, and the part 110 is inserted into the end of the tube, on the side of the flange 11. It should be
15 noted that, advantageously, there is provided, between the flange 11 and this end of the tube, for a passageway 111 allowing the hydraulic fluid F to reach the seal 112 of the flange 11, in order to protect this seal 112.

 It should be noted that, advantageously, the passageway 111 ends into the peripheral space 14 where the hydraulic fluid F is never subjected to high pressure
20 created by piston 20 during the impact, this also applies to the seal 112.

 When referring now to figures 4a and 4b, one can see a mode of manufacturing of the device according to the invention, and in particular as regards the element 3 forming a check valve, the tubular jacket 13 and the radial holes 15.

 On the one hand, the jacket 13 has a difference in level, actually a difference in
25 thickness, which creates a shoulder 130 aimed at forming the seat and, thus, at receiving the end 32 of the element 3 when the latter is brought back by the spring 30.

 It should be noted that the device shown in figure 3 is made according to this mode of construction.

 On the other hand, the jacket 13 peripherally includes, on the side of evolving
30 of the movable element 3, a groove 131 on the bottom of which are provided for the holes 15, and one wall of which coincides with the shoulder 130.

This construction advantageously allows not to limit the flow of the fluid F to the diameter of the holes 15, since it can be carried out over the full periphery in the space provided between the shoulder 130 and the end 32 of the element 3 during the displacement of the latter, as can be seen in figure 4b.

5 When referring now to figure 5, one can see a second embodiment 4 of the device according to the invention. In this embodiment, contrary to the one shown in figures 1 and 2 where the element forming a check valve is fitted on the body 10, one can see that it can be fitted on the piston.

10 This embodiment 4 comprises a body 40 filled with hydraulic fluid F, in which can move a rod 5 provided, at its one end, with a piston 50 which divides the inner space of the body 40 into a first chamber 41 and a second chamber 42.

The inner wall 43 of the body 4 at the level of the first chamber 41 has a narrowing so as to allow an escape of flow decreasing with the insertion of the piston 50.

15 The piston 50 includes, on the side of the second chamber 42, openings 51, as well as, peripherally on the side of the first chamber 41, openings 52, which are sealed by an annular element 53 forming a check valve, axially mobile and pushed back in the direction of closing by a spring 54, i.e. in the direction opposite the insertion of the piston 50 into the first chamber 41.

20 The operation of this device 4 is similar to that of the device 1, i.e. it is conditioned by the element 53 forming a check valve.

It should be noted that the features described in figures 4a and 4b can also relate to this embodiment.

25 When referring now to figure 6, one can see a third embodiment 6 of the device according to the invention. This device 6 is associated with a system 7 of retractable steering column 70. This system 7 comprises supports 71 fixedly integral with the vehicle, in which can slide the steering column 70 for its retractability at the time of a violent impact applied to the steering wheel.

30 The device 6 comprises a body 60, which is in the form of a tubular jacket filled with hydraulic fluid F, limited on one side by a bottom 61 and on the other side by a flange 62, which will be described more in detail hereafter.

Through the flange 62 passes a rod 8 provided, at its end internal to the body 60, with a piston 80. As shown in figure 6, before operation, the rod 8 is drawn inside, the piston 80 is in contact with or in the vicinity of the bottom 61, and it delimits in the body 60, while authorizing some escape, a first chamber 63 between the latter and the flange 62 and, between the latter and the bottom 61, a second chamber 64, not yet
 5 existing in figure 6, since the piston 80 is in contact with the bottom 61.

The flange 62 has particular characteristics related to the fact that the device 6 should operate only once, and that the tightness must be guaranteed during the full life of the vehicle that is provided with it. To this end, it is manufactured without any
 10 dynamic part such as a seal.

The flange 62 thus comprises two parts that co-operate, namely a cylinder head 9 through which passes the rod 8, and a part 81 integral with the end of the rod 8, the cylinder head 9 and the part 81 being crimped onto the body 60 by means of a ring 65.

The part 81 comprises two portions, a peripheral portion 82 in the form of a
 15 disc, which is crimped by the ring 65, and a central portion 83 made integral with the end of the rod 8, these two portions 82 and 83 being connected by an area 84 of a lower resistance allowing, under some tensile force, to separate both portions 82 and 83.

The cylinder head 9 includes two portions, a peripheral portion 90 in the form of a disc, which is crimped by the ring 65, and a central portion 91, which has a tubular
 20 shape and extends in the body 60 and which is closed, on that side, by a bottom 92. The portions 90 and 91 are united by an intermediate area drilled with holes 93 authorizing the hydraulic fluid F to flow until the portion 81.

The portion 91 contains a tubular element 94 forming a check valve, pushed back through a spring 95 intercalated between the latter and the bottom 92, against the
 25 portion 81, or more exactly the peripheral portion 82 in the form of a disc of the latter, in order to seal the holes 93.

The device 6 is associated with the system 7 as follows, the body 60 is integral with the column 70, while the part 81 is maintained integral by its central portion 83 with the supports 71 fixedly integral with the vehicle.

30 When referring also to figures 7a, 7b and 7c, one can understand the operation of the device 6. At the time of an impact I onto the steering wheel, the latter is

transmitted to the body 60 through the steering column 70, which is inserted, while the supports 71 remain fixed and maintain the portion 83 of the part 81.

Under the impact I, the area 84 breaks and the parts 82 and 83 separate from each other, the piston 80 relatively moves in the body 60 while compressing the
5 hydraulic fluid F in the first chamber 63, while the escape allows the filling of the second chamber 64.

When the deceleration of the body 60 has reached a certain level, the element 94 continues its impetus so as to de-obstruct the holes 93 and to authorize an escape of hydraulic fluid F towards the outside, thus reducing the pressure in first chamber 63,
10 and therefore the deceleration.

One thus achieves a power-assisted damping of the retraction of the steering column, which provides the same level of safety to all drivers, irrespective of their stoutness.

It should be noted that according to a variant of the device 6, applied to a
15 system of power-control of a steering column or to another system, the piston 80 is designed tight or nearly tight, so that there is no escape towards the second chamber, and that this escape occurs only towards the outside.

From the point of view construction, irrespective of the embodiment involved, the various elements are made out of usually used materials such as metals, but also
20 plastics.

CLAIMS

1. Damping device (1; 4;6) with power-assisted deceleration, for use in the field of the hydraulic shock absorbers, of the type comprising a sealed body (10 ; 40 ; 60) filled with hydraulic fluid (F), in which is mounted a piston (20 ; 50 ; 80) integral with a rod (2 ; 5 ; 8) capable of being moved axially out of said body (10 ; 40 ; 60), said rod (2 ; 5 ; 8) and said body (10 ; 40 ; 60) being arranged so that a strike against one of them, while the other one is integral with a support, causes the axial displacement of the piston (20 ; 50 ; 80) and the compression of said fluid (F) in a chamber (16; 41; 63), characterized in that it comprises, on the one hand, flow means (15; 52; 93) designed capable of allowing said hydraulic fluid (F) to be released from said chamber (16; 41; 63) and, on the other hand, an element (3 ; 53 ; 94) which can move axially inside said body (10 ; 40 ; 60) and which is designed capable of forming a check valve for closing said flow means (15; 52; 93) when pushed back in the direction opposite to that of the impact (I) by elastic means (30 ; 54 ; 95), said movable element (3 ; 53 ; 94) being designed capable of being subjected to the initial speed of said impact (I), so that its displacement depends on its mass and on the compressive strength of said elastic means (30 ; 54 ; 95).

2. Device (1 ; 4 ; 6) according to claim 1, characterized in that the piston (20 ; 50 ; 80) delimits in the body (10 ; 40 ; 60) two chambers, a first compression chamber (16 ; 41 ; 63) for the fluid (F), and a second chamber (17 ; 42 ; 64) for collecting the hydraulic fluid (F) coming from said first chamber (16 ; 41 ; 63) and proceeding from an escape provided for at the level of said piston (20 ; 50 ; 80).

3. Device (1 ; 4 ; 6) according to claim 1 or claim 2, characterized in that the transverse dimensions of the portion of the body which delimits the compression chamber (16 ; 41 ; 63) are decreasing, linearly or not, in the direction of the displacement of the piston (20 ; 50 ; 80) during the compression of said chamber (16 ; 41 ; 63), so as to create a narrowing.

4. Device (1 ; 4 ; 6) according to any of the preceding claims, characterized in that the movable element forming a check valve (3 ; 53 ; 94) has an annular or similar form, and is inserted onto or into a part of a globally tubular shape (13 ; 50 ; 91), which includes the means (15 ; 52 ; 93) for the hydraulic fluid (F) to flow out of the

compression chamber (16 ; 41 ; 63), one of its edges (32) being intended to come into contact with a portion (11 ; 130 ; 82) of the body (10 ; 40 ; 60) which forms the seat of said valve (3 ; 53 ; 94).

5 5. Device (1 ; 4 ; 6) according to claim 4, characterized in that the edge (32) of the movable element (3 ; 53 ; 94) forming a check valve, intended to come into contact with the seat (11 ; 130 ; 82), has on its face opposite that which seals the flow means (15 ; 52 ; 93), a chamfer (31) conferring to said edge a whistle-like profile.

10 6. Device (1 ; 4) according to claim 4 or claim 5, characterized in that the seat consists of a shoulder (130) resulting from a difference in level of the part with a globally tubular shape (13 ; 50) on or in which is inserted the movable element forming a check valve (3 ; 53).

15 7. Device (1 ; 4) according to any of claims 4 to 6, characterized in that the flow means (15 ; 52) consist of holes (15) provided for in a peripheral groove (131) the part (13 ; 50) of a globally tubular shape includes on the side of evolving of the movable element forming a check valve (3 ; 53).

8. Device (1 ; 4) according to any of claims 2 to 7, characterized in that means (15 ; 52) for the fluid (F) to flow out of the compression chamber (16 ; 41) are associated with means allowing to transfer the fluid flown out into the second chamber (17 ; 42).

20 9. Device (4) according to any of claims 2 to 8, characterized in that the means (52) for the fluid (F) to flow out of the compression chamber (41) are arranged at the level of the piston (50).

25 10. Device (4) according to claim 9, characterized in that the piston (50) includes openings (51) on the side of the second chamber (42), as well as peripherally openings (52) on the side of the compression chamber (41), the latter being sealed by a movable element (53) forming a check valve and pushed back by an elastic means (54) in the direction opposite to the insertion of said piston (50) into said compression chamber (41).

30 11. Device (1) according to any of claims 1 to 8, characterized in that the means (15) for the fluid (F) to flow out of the compression chamber (16) are arranged at the level of the body (10).

12. Device (1) according to claim 11, characterized in that the tubular body (10) contains a tubular jacket (13) which accommodates the piston (20), and whose ends are formed so to allow a communication of the peripheral space (14) with the interior of said tubular jacket (13), in order to form, on one side, the means (15) for the fluid (F) to
5 flow out of the compression chamber (16) and on which is slideably guided the movable element forming a check valve (3).

13. Device (6) according to any of claims 1 to 5, characterized in that the body (60) is in the form of a tubular jacket filled with hydraulic fluid (F), limited, on one side, by a bottom (61) and, on the other side, by a flange (62) through which passes a
10 rod (8) provided at its end, internal to the body (60), with a piston (80) which delimits with said flask (62) the compression chamber (63).

14. Device (6) according to claim 13, characterized in that the flange (62) comprises two parts crimped onto the body, a first one (9) which consists of a cylinder head incorporating the means (93) for flowing out of the compression chamber (63)
15 and a part of a globally tubular shape (91) which contains the movable element forming a check valve (94), and a second one (81) forming the seat of said check valve (94).

15. Device (6) according to claim 14, characterized in that the second part (81) comprises two portions, a peripheral portion (82) in the form of a disc and a central portion (83) made integral with the end of the rod (8), these two portions (82, 83) being
20 connected by an area (84) of lower resistance aimed at breaking under a certain tensile force.

16. Application of the device (6) according to any of claims 13 to 15 to the damping of a retractable steering column (7) of a motor vehicle and in which, the body (60) of said device (6) is integral with the portion (70) of the steering column movable
25 with respect to the vehicle, while the rod (8) is integral with said vehicle, so that the displacement of said moving porting (70) causes said rod (8) to be extracted out of said body (60) and the compression by the piston (80) of the compression chamber (63).