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

(11) Publication number: **0 360 761**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **89830333.4**

(22) Date of filing: **18.07.89**

(51) Int. Cl.[5]: **E 01 F 15/00**

(30) Priority: **25.08.88 IT 2175388**

(43) Date of publication of application:
28.03.90 Bulletin 90/13

(84) Designated Contracting States:
AT BE CH DE ES FR GB LI NL

(71) Applicant: **MAMMUTH TYRES S.r.l.**
Via Brennero, 19
I-38068 Rovereto (Trento) (IT)

(72) Inventor: **Marangoni, Paolo**
Mammuth Tyres S.r.l. Via Brennero 19
I-38068 Rovereto (Trento) (IT)

(74) Representative: **Cicogna, Franco**
Ufficio Internazionale Brevetti Dott.Prof. Franco Cicogna
Via Visconti di Modrone, 14/A
I-20122 Milano (IT)

(54) Controlled-yielding pneumatic bag for absorbing impacts of vehicles.

(57) The pneumatic bag consists of a flexible tubular element (1) which is closed, at the two ends thereof, by corresponding locking disc members (2, 3): one of these disc members, in particular, coaxially supports a hollow body (4) which communicates with the inside of the tubular element and with the outside environment through suitably arranged slots (9, 10).

Inside the hollow body two coaxial tubular bodies (11, 14) can slide in opposite directions, each of which is counterbiassed by a respective spring (13, 15), the coaxial tubular bodies being also provided with suitably arranged circumferential slots (12).

A coordinated motion of the tubular bodies is so designed as to interrupt communication between the inside of the tubular element and outside environment so as to cause the tubular element to fully absorb an impact due to the colliding vehicle and/or the like.

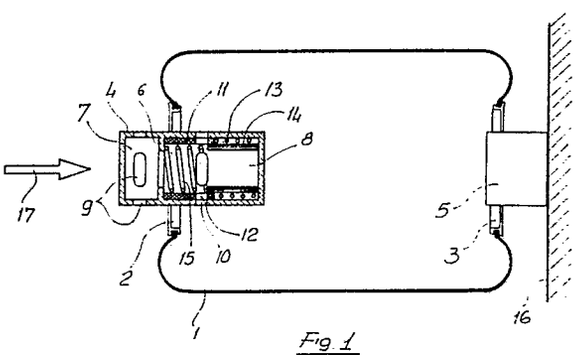

Fig 1

EP 0 360 761 A1

Description

CONTROLLED-YIELDING PNEUMATIC BAG FOR ABSORBING IMPACTS OF VEHICLES

BACKGROUND OF THE INVENTION

The present invention relates to a controlled-yielding pneumatic bag for absorbing impacts of vehicles and self-moving apparatus in general.

As is known, each road path comprises zones or portions of great potential danger, thereat there are usually arranged anti-accident protecting means.

As conventionally implemented, these protecting means consist generally of rigid systems (walls and the like) or semirigid systems (such as guard-rails) or systems adapted for being permanently deformed (such as metal posts) which are conventionall arranged at the edge portions of a road.

Also known is the fact that in the case of not usual paths (such as race paths and the like) there are provided, as protecting means, straw bales, worn pneumatic tires, metal nets and the like which, for providing sufficient safety characteristics must operate, as impact absorbing elements.

On the other hand, known protecting systems are affected by several drawbacks. In fact, a guard-rail operates as an impact damper element exclusively if it is tangentially impacted, so as to elongate as far as possible the contact region with the impacting vehicle, the damping effect depending on the permanent deformations of said guard-rail.

Metal posts, in turn, are efficient exclusively if they are suitably deformed, that is exclusively if the impacting vehicle trajectory coincides with the subsequent positions of these posts.

In each case, on the other hand, in conventional standardized anti-accident systems of the above mentioned type, the impact is exerted against elements having a comparatively high specific stiffness which are specifically designed for transmitting to the impacting vehicle high concentrated reaction forces.

SUMMARY OF THE INVENTION

Accordingly, the present invention sets out to overcome the above mentioned drawbacks, by providing a pneumatic bag or "cushion" member,adapted to absorb impacts from vehicles in general,which is exclusively operated by atmospheric pressure air.

Within the scope of the above mentioned aim, a main object of the present invention is to provide such a vehicle impact absorbing pneumatic bag which is very simple construction-wise and very reliable in operation.

Another object of the present invention is to provide such a pneumatic bag which can be specifically designed depending on the use requirements and can be constructed as a modular unit adapted for association with a plurality of like interconnected modular units.

According to one aspect of the present invention, the above mentioned aim and objects, as well as yet other objects, which will become more apparent hereinafter, are achieved by a controlled-yielding pneumatic bag for absorbing impacts of vehicles characterized in that said bag essentially consists of a flexible tubular element closed at the two ends thereof by corresponding disc members, one of said disc members coaxially supporting a hollow body which communicates with the inside of said tubular element and with the outside environment through suitably arranged slots; inside said hollow body, or valve body, being provided two coaxial tubular bodies adapted to slide in opposite directions, each of said coaxial tubular bodies being counterbiassed by a respective spring, said coaxial tubular bodies being also provided with circumferential slots, said tubular bodies being arranged and designed so as to interrupt, upon sliding, the communication between the inside of said tubular element and outside environment, so as to cause said tubular element to fully absorb an impact caused by a colliding vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages of the anti-accident pneumatic bag of cushion member according to the invention, will become more apparent from the following detailed disclosure of a preferred embodiment thereof, which is illustrated, by way of an indicative but not limitative example, in the figures of the accompanying drawings, where:

Figure 1 schematically shows the pneumatic bag according to the invention in a rest condition thereof;

Figures 2, 3 and 4 show possible configurations assumed by the tubular element and other components of said pneumatic bag following an impact from a vehicle or self-moving apparatus.

DESCRIPTION OF THE PREFERRED EMBOIDMENTS

With reference to the figures of the accompanying drawings, the anti-accident pneumatic bag according to the invention comprises a flexible tubular element 1 consisting of metal and/or synthetic and/or naturally occurring threads, said structure being coated by vulcanized rubber.

This tubular element, of preferably round cross-section and horizontal axis, is closed, at the two ends thereof, by corresponding closure disc members 2 and 3 which respectively coaxially support a hollow body or valve body 4 and a rigid buffer or stopper 5.

More specifically, the valve body is provided with an intermediate narrowed portion 6 which defines an outer chamber 7 and inner chamber 8 with respect to said tubular element.

Through the mentioned two chambers, in particular, there are formed circumferential slots respectively indicated at the reference numbers9 and 10.

In the inner chamber 8 there is housed a first tubular body or slider 11 which is also provided with circumferential slots 12 and being counterbiassed by a helical coil spring 13.

In that same inner chamber 8 there is moreover provided a first tubular body 14, coaxially extending inside the first tubular body and being in turn counterbiassed by a respective helical coil spring 15 engaging against the mentioned narrowed portion 6.

In this connection, it should be pointed out that the mentioned rigid stopper 5 operates as a bearing member for the thus constructed assembly against the abutment member 16 adapted to operate as a reaction member against an impact caused by a colliding vehicle, and also adapted to operate as an end of stroke stop element for the valve body 4.

More specifically, the mentioned valve body 4 is so designed and arranged that the sole connections of said valve body between the inner volume of the tubular element and the atmosphere consist of the mentioned slots 9 and 10.

These slots, in particular, are so arranged that, with the valve body in a rest condition, the slider members 11 and 14, counterbiassed by their respective springs 13 and 15 provide a natural coupling of the ports or slots 9 and 10 of said valve body, so as to allow for air to freely enter the inside of said tubular element or envelope 1 to communicate with the atmosphere and vice-versa.

In this connection it should be apparent that any axial sliding displacements of one of the mentioned slider members or of both said slider members, in an amount greater than the width of the slots 10, will interrupt or shut off the connection between the tubular element or envelope inside and the atmosphere, thereby causing the kinetic energy ab sorbing step to start.

More specifically, as a vehicle, or self-moving apparatus, as indicated generally by the arrow 17, having a given speed and, accordingly, a given motion amount, collides against the front of the subject pneumatic bag, the valve body 4, closure and locking disc member 2 and front portion of the tubular element 1 will instantaneously pass from a zero speed to the colliding vehicle speed.

Accordingly, the slider member 14 will be subjected to such a force that it will overcome the counterbiassing spring 15 force and "cover" as shown in figure 2, the slots 10 so as to trap all of the air contained at atmospheric pressure in the envelope or tubular member 1.

At this time, the kinetic energy of the colliding vehicles starts to be transferred to the inside of the tubular element and this tubular element, as it volume is decreased because of its resiliency and deforming properties, will allow for air contained therein to be adiabatically pressed (in fact, because of the very short duration of the phenomenon it is possible to assume that there is no energy dispersion by thermal transmission through the walls of the tubular element).

Thus, in actual practice, the inner air energy increase will correspond, instant by instant, to the kinetic energy being lost by the colliding vehicle.

During the energy absorbing period, the valve body 4 will be subjected to an inertial force having an opposite direction to that generated by the impact.

This phenomenon will subject the slider members 11 and 14 to an impulsive force which, while tending to relocate the slider member 14, causes the slider member 11 to slide in the same direction, by overcoming the force of the spring 13, so as to cover (as is shown in figure 3) the slot 10.

Accordingly, the valve closure characteristic can be considered as a continuous closure characteristic and, accordingly, also the kinetic energu will be absorbed in a continuous manner.

As the speed of the colliding vehicle becomes zero (that is as its energy has been completely absorbed), all of the component elements of the absorbing system will pass to a rest condition and, accordingly, any pulses due to the vehicle momentum will stop.

Thus, the slider members 11 and 14 will be relocated at the home positions (figure 4) and will open the connection between the inside of the tubular element 1 and atmosphere, thereby allowing for pressurized air to be immediately discharged so as to prevent a undesired recoiling phenomenon from occurring.

In this connection, it should be apparent that the above disclosure specifically relates to the performance of an ideal valve body adapted to hold trapped therein air for the overall duration of an impact assorbing phenomenon, from the time of the impact to the complete stopping of the colliding vehicle without any recoiling.

On the other hand, if it is admitted that th energy absorption can occur under transition conditions, which, for a very short period are susceptible to dissipate the air pressure before e complete stopping of the vehicle, then it will be possible to design the mentioned valve body with the sole slider member 14 and related biassing spring.

This slider member, which closes the valve at the impact instant, holds the valve in a closed condition as far as the impact energy holds said slider member at its slot 10 covering position because of the resilient deforming of the biassing spring and during the relocating step.

In particular, if the relocating of said slider member prematurely occurs, then, since said slider member has a speed greater than that of the valve body 4, said slider member will bounce against the bottom of said valve body, so as to cover again the slots 10.

This mode of operation will be repeated until the colliding vehicle has been completely stopped, that is as far as the valve body 4, starting to recoil, reverses its displacement while holding the slider member 14 against the bottom of said valve body.

In this connection it should be pointed out that to the transitory opening of the slots 10 will correspond to an air outflow from the inside of the mentioned envelope and to a corresponding efficiency loss of the overall system.

However, if the valve body is properly designed,

then the opening time will be so short that it will not appreciably limit the operating characterists of the system.

Thus, it should be apparent that the above disclosed anti-accident absorbing bag is adapted, by using atmospheric pressure air, to firstly absorb and then dissipate the kinetic energy of a moving vehicle.

In particular, this dissipation of the absorbed kinetic energy is carried out through the valve body 4 precisely at the instant therein the colliding vehicle has been stopped and upon fully pressing the envelope 1 against its rear buffer or mechanical end of stroke element.

Another important feature of the invention is that the disclosed valve body is insensible, in its designing range to the physical characteristics of the motion of the colliding vehicle; this is due to the fact that the sole physical factor which controls its operation consists of the status variation of the motion of the component elements of the system. Accordingly, under motion conditions, the inertial unbalancing of the slider members 11 and 14 will provide absorbing favorable positions.

It should be moreover added that the envelope 1, which preferably consists of a vulcanized and belted rubber cylinder, likewise to a smooth pneumatic tire, has such a shape and volume which is related to the provided absorbing capabilities and, if desired, it can also be made as a bellows or the like elements.

Moreover, the specific horizontal axis structure of the subject anti-accident bag, affords the possibility of arranging a plurality of like bags in a coupled relationship with respect to one another, the connection being made by slide floor sliding supporting elements so as to provide a very efficient and high absorbing capability system.

For a better understanding of the subject system operation, it should be points out that, since the resilient envelope is belted by an inextensible thread interlacing, as the length of said system is reduced, its inner volume will be reduced proportionately to the length reduction, since the envelope will be subjected to bellows type of ondulations.

Accordingly, the subject system operates substantially as a plunger which, as it is subjected to an impact, will press an air chamber or bladder closed by a plug, which is disengaged, at the end of the pressing phenomenon (with the colliding vehicle in a stop condition), that is before the kinematic discharging of the inner pressure energy.

According to he main perfect gas law (since air can be considered a perfect gas), $PV = RT$, and, considering the physical characteristics of an ad abatic compression, we will have $PV^k = \text{const}$, and the condition of the air volume trapped in that envelope can be expressed according to different manners, that is: $V_2 = R \times T_2/P_2$ and $V_2 = (P_1/P_2^{1/k} \times V_1$, and, accordingly we will have:

1) $R \times T_2/P_2 = (P_1/P_2)^{1/k} \times V_1$

Hence, since the energy corresponding to an adiabatic transformation is expressed by the relationship: $E = \text{const.} \times \text{air weight} \times (T_2 - T_1)$, it is possible to obtain T_2 by knowing T_1 (the absolute temperature of the envelope air, at atmospheric pressure); knowing that the input energy of the system is $E = 1/2\ mc^2$ and considering such an air weight (the amount of the air held in the envelope) that the consequent pressure P_2 (from 1) at T_2 can be supported by the system component elements.

Moreover, the geometric characteristics of the envelope will be designed so as to allow for a sufficient braking space in order not to exceed deceleration values greater than those which has been experimentally found as dangerous (the highest decelerations occur, at the end of the braking as the reaction due to the pressure of the air held in the envelope is the highest).

In this connection it should be moreover pointed out that the efficiency of the system will be the highest as, at the absorbing period, the pressure energy in the envelope is immediately dissipated to the atmosphere notwithstanding the very short duration of the phenomenon and the present invention actually has the physical characteristics providing it with a maximum efficiency.

In fact, the spring included in the subject system have ben mechanically designed so as to slightly advance the valve opening with respect to the colliding vehicle stopping. Thus, the deformation of the spring, and related displacement of the slider members and hence the closure of the outflow duct will be proportional to the impact intensity, and, accordingly, the valve closure time will be effectively optimal.

While the invention has been disclosed and illustrated with reference to a preferred embodiment thereof, it should be apparent that the disclosed embodiment is susceptible to several modifications and variations, all of which will come within the spirit and scope to the appended claims.

Claims

1. A controlled- yielding pneumatic bag for absorbing impacts of vehicles, characterized in that said bag essentially consists of a flexible tubular element closed at the two ends thereof by corresponding disc members, one of said disc members coaxially supporting a hollow body which communicates with the inside of said tubular element and with the outside environment through suitably arranged slots, inside said hollow body, or valve body, being provided two coaxial tubular bodies adapted to slide in opposite directions, each of said coaxial tubular bodies being counterbiassed by a respective spring, said coaxial tubular bodies being also provided with circumferential slots, said tubular bodies being so arranged and designed as to interrupt, upon sliding, the communication between the inside of said tubular element and outside environment, so as to cause said tubular element to fully absorb an impact caused by a colliding vehicle.

2. A pneumatic bag, according to claim 1, characterized in that said flexible tubular element consists of metal and/or synthetic and/or naturally occurring threads, coated by a vul-

canized rubber, and has such a shape and volume which depends on the provided energy absorbing capabilities.

2. A pneumatic bag, according to claim 1, characterized in that said tubular element has a bellows shape.

3. A pneumatic bag, according to one or more of the preceding claims, characterized in that said tubular element has a round cross-section and a horizontal axis, said tubular element being closed at the end portions thereof, by corresponding closure disc members which coaxially support said valve body and a rigid buffer.

5. A pneumatic bag, according to one or more of the preceding claims, characterized in that said valve body is provided with an intermediate narrowed portion defining an outer chamber and inner chamber with respect to said tubular element, circumferential slots being formed through the walls of said two chambers.

6. A pneumatic bag, according to one or more of the preceding claims, characterized in that in said inner chamber there is housed a first tubular body, a slider member, also provided with circumferential slots and being counterbiassed by a coil spring, in said inner chamber there being moreover provided a second tubular body, coaxially extending inside the first tubular body and in turn counterbiassed by a respective coil spring engaging against said narrowed portion.

7. A pneumatic bag, according to one or more of the preceding claims, characterized in that said rigid buffer abuts against an abutment member adapted to operate as a reaction member against an impact caused by said colliding vehicle as well as operating as an end of stroke member for said valve body.

8. A pneumatic bag, according to one or more of the preceding claims, characterized in that said valve body comprises a single slider member with a related counterbiassing coil spring.

9. A pneumatic bag, according to one or more of the preceding claims, characterized in that said pneumatic bag is made as a modular unit adapted to be coupled to like modular units to provide a high impact absorbing capability system.

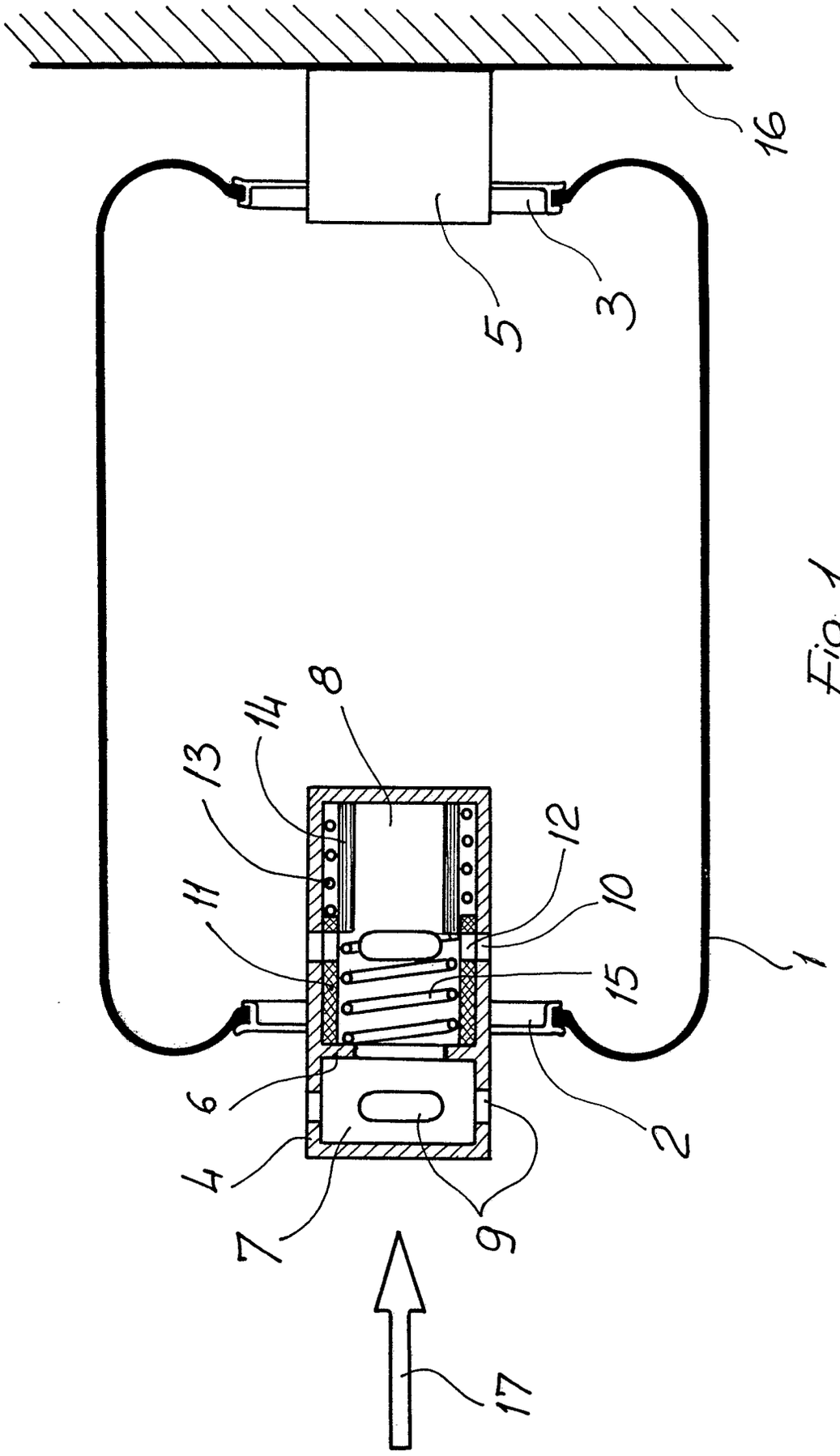

Fig. 1

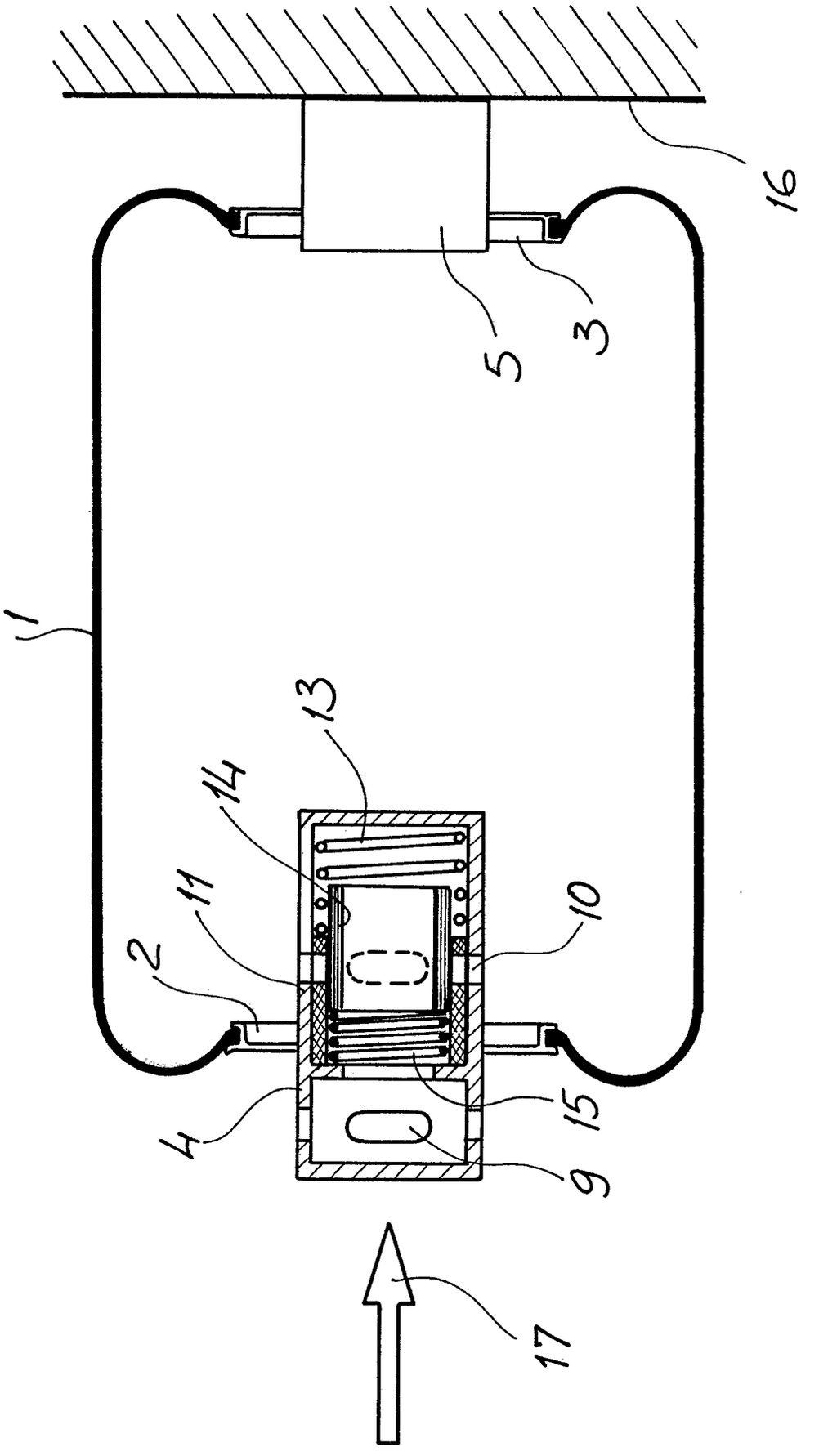

Fig.2

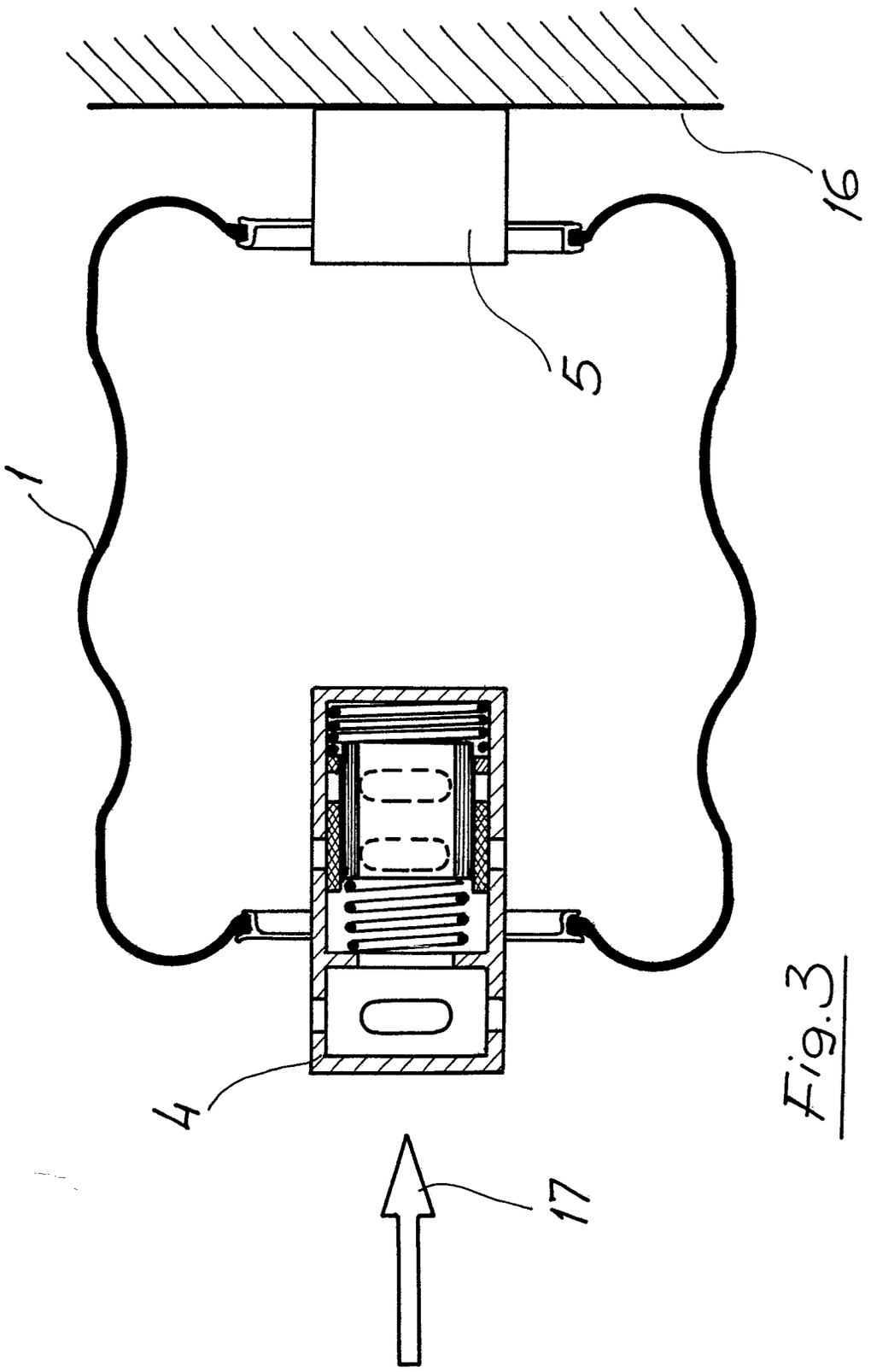

Fig.3

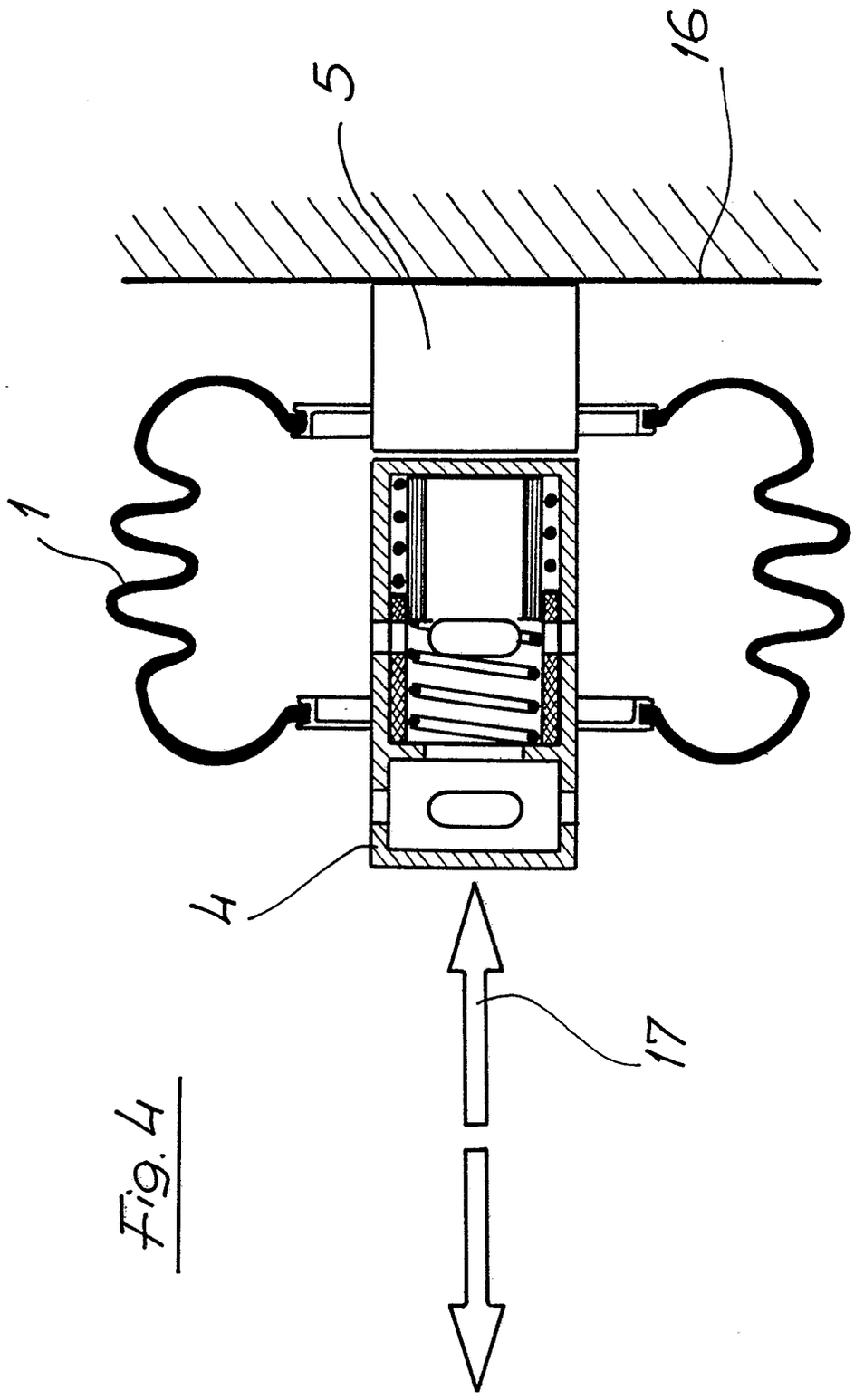

Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 83 0333

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 165 738 (ENERGY ABSORPTION SYSTEMS INC.) * complete document *	1,3,4,9	E 01 F 15/00
A	DE-U-7 420 685 (SCHOEMBURG) * complete document *	1,2,9	
A	US-A-3 661 359 (B. WALKER) * column 1, lines 39-75; figures 1-4 *	1,2,9	
A	AT-B- 281 892 (A. GUZZARDELLA) * page 2, line 5 - page 4, line 45; figures 1-31 *	1,2,9	
A	DE-A-2 510 106 (ROAD RESEARCH LTD.) * pages 1-10; figures 1-3 *	1	
A	US-A-3 690 619 (G. A. KENDALL) * complete document *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 01 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	17-11-1989	PAETZEL H-J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)