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(54) **Inertia sensor for seat belt retractors**

(57) An inertia sensor especially for seat belt retractors including a ball (1) as the inertia part, an opening (11) extending through the ball, and a holding pin (3) extending through the hole and into a hole (22) in a supporting ring (27) on which the ball rests in circular line contact so as to be tiltable in any direction. The pin 3 which is of a plastics material, has a mushroom shaped head 31 which cooperates with a hemispherical surface 43 of a trigger arm pivoted at 41 to raise the tip 42 of the arm to engage the ratchet wheel of an inertia reel seat belt when the sensor is subjected to acceleration.

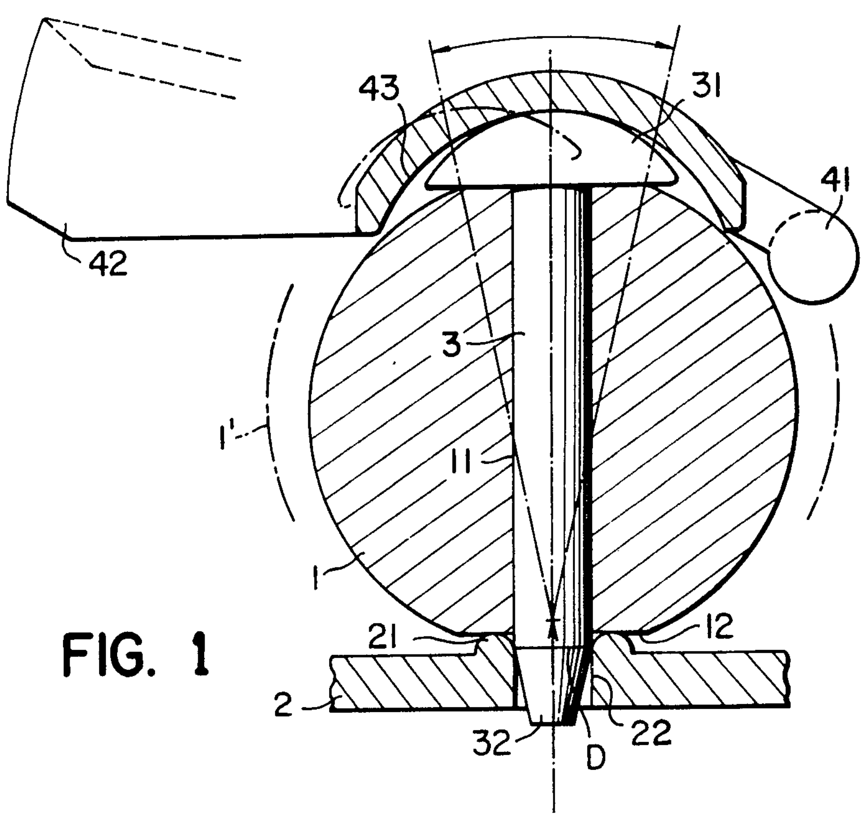

FIG. 1

The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

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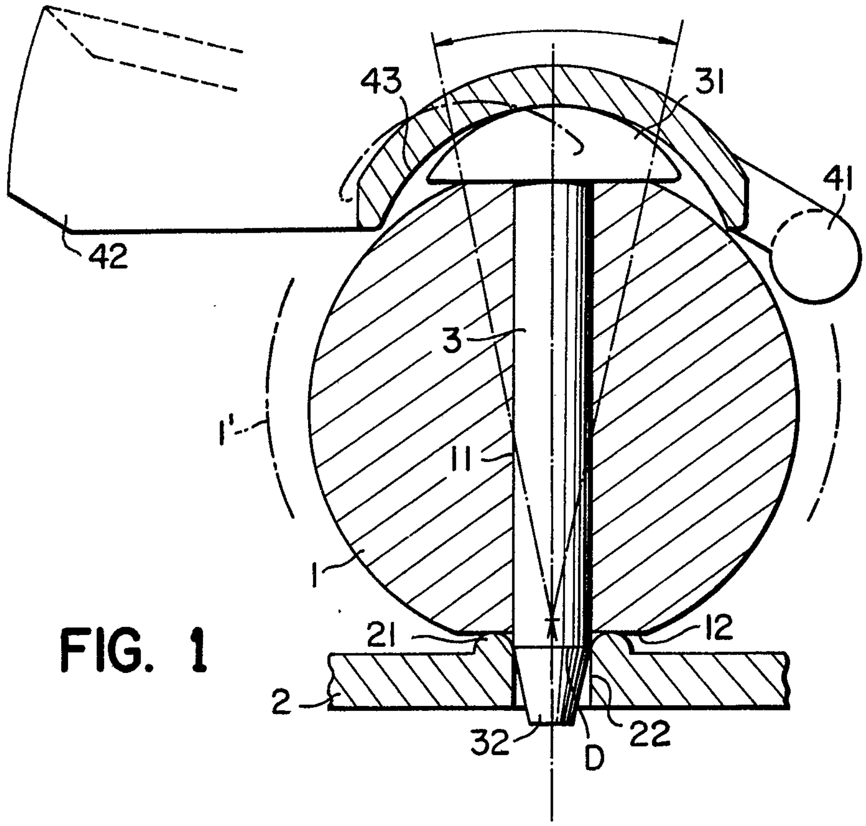

FIG. 1

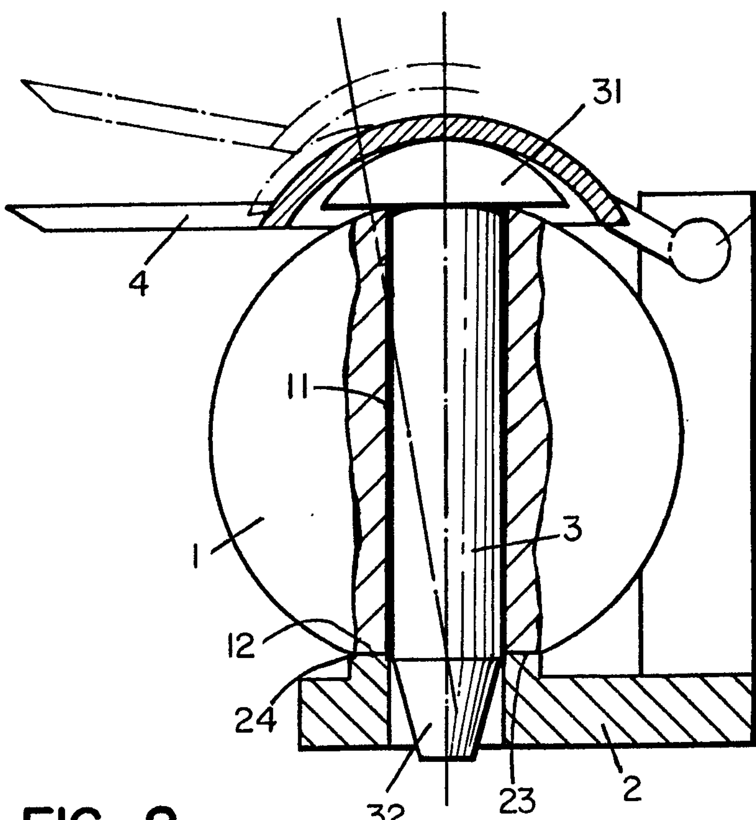

FIG. 2

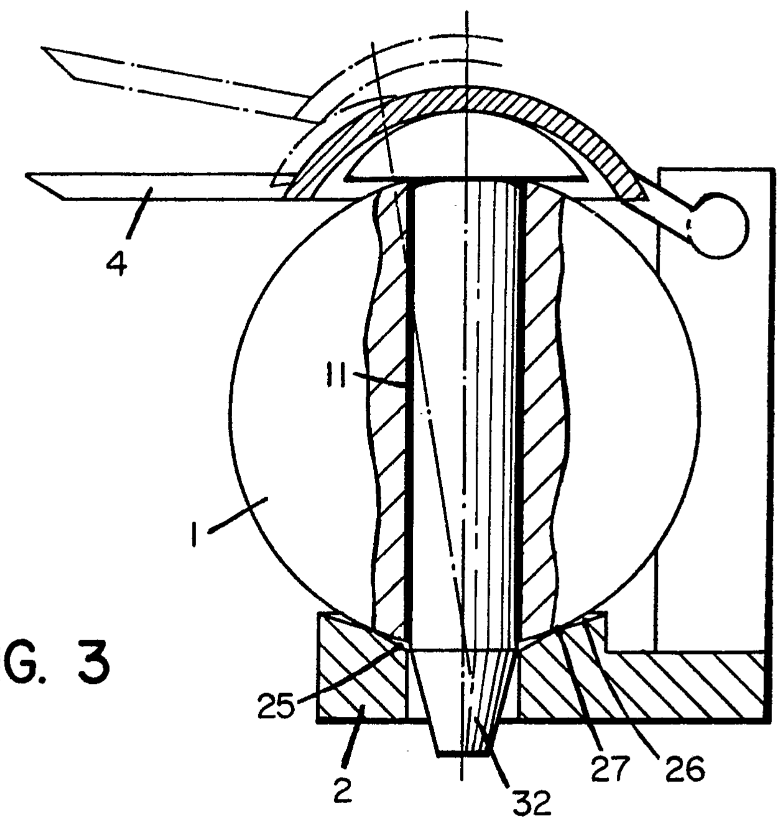

FIG. 3

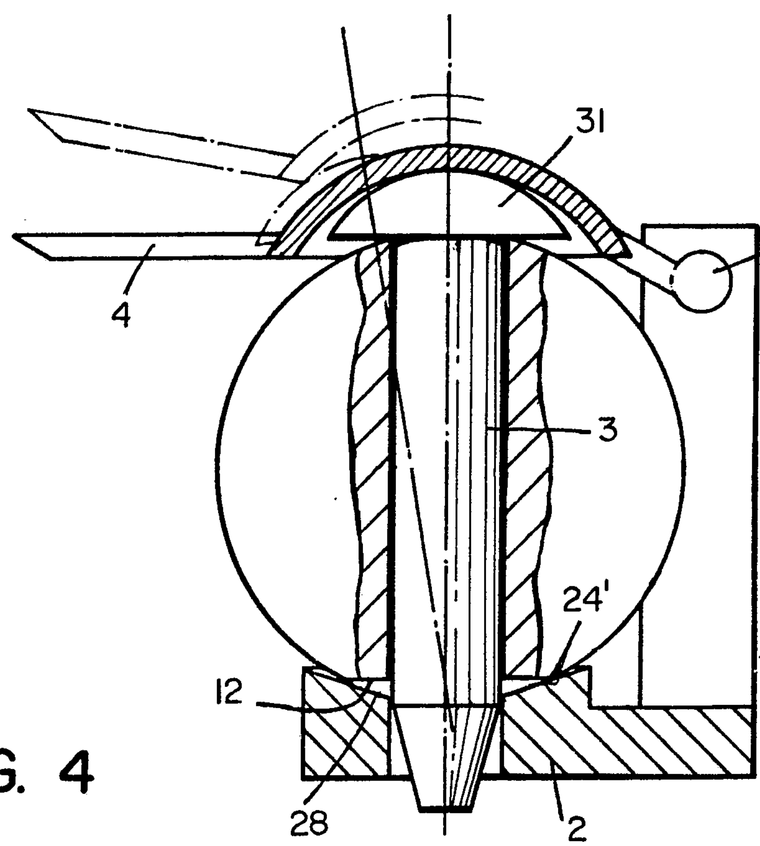

FIG. 4

SPECIFICATION

Inertia sensor for seat belt retractors

Background of the Invention

The invention relates to an inertia-dependent sensor with an inertia part retained in a supporting part so as to be freely movable on a ring fixed to the housing, and with a pivotably mounted trigger arm, movable by the inertia part, to release and/or lock safety members, e.g. a ratchet wheel in a belt winder, inflation of an air cushion, extension of a head rest, in particular for motor vehicles.

Many types of inertia-dependent sensors, in particular in locking devices for motor vehicles, are known, the US Patent No. 3,901,461 or the German Application 2 731 072 being referred to, among others. A hanging pendulum or a standing inertia part mounted at the bottom can be imagined as inertia-dependent sensor. In the so-called automatic devices, i.e. in those belt winders for safety belts in which slow pulling out of the belt from the winding device is possible while a locking action takes place if pulled out quickly or when the vehicle is accelerated, a suspended pendulum, rolling balls as well as tilting inertia parts have been employed as inertia-dependent sensors. These known inertia-dependent sensors have the disadvantage of often working unreliably and of being costly, not only in production, but also in their assembly and installation.

One imperfect function has frequently been observed in hanging pendulums as the inertia member. The stability criteria for such a pendulum are that it starts tilting from a certain initial angle on. As is known, this initial angle is the position in which the pendulum's center of gravity is under its point of support. Now, if, starting from this initial angle, the angle is increased by a small amount by tilting the supporting ring, the pendulum will react by swinging by only just this increased angle amount. In other words, the hanging pendulum reacts disadvantageously very slowly when the acceleration at the instant of an accident are small.

It goes without saying that this characteristic is undesirable. In addition, the hanging pendulum has the further disadvantage that it frequently represents a very nervous sensor when being installed. This means that the sensor readily picks up vibrations or motions of the moving vehicle, whereupon it starts swinging. Belt winders equipped with such an inertia-dependent sensor are usually inconvenient to use, particularly because they are too often in the locking position.

The hanging pendulum is also disadvantageous in view of its expensive manufacture and assembly. For instance, after screwing the pivot shaft into the suspension bearing, the pendulum weight must be pressed onto this shaft.

As mentioned above, metal balls are known as inertia parts. In the state of the art, designs to retain such inertia balls with binary effect have already been developed, in which the hanging or standing inertia ball either hangs or stands in its position at rest or it is moved completely into the titled position. It has been attempted there to retain the known inertia ball in a hole or in a tapered seat, with the taper widening upwardly. But it is also known, on the other hand, that these sensors cannot be made with desired degree of accuracy. A taper seat can especially become dirty through dust or condensed water. Of disadvantage is also the considerable noise made by the known belt winders when the metal balls hit the metal parts enclosing them.

But one important disadvantage of the known inertia balls is the fact that the first motion of the ball moved by an acceleration, such as at the instant of an accident, is not its rolling motion, but a sliding motion. Therefore, even small variations of the coefficient of friction of the ball material and the suspension material become very significant. As is known, a ball or a cylinder on an inclined plane always begins it motion by sliding. Now, the moment of inertia when rotating hinders the inertia part at the beginning in starting to roll at all. This plays a role especially when the ball is impeded or hindered to a certain degree from starting to roll by the additional circumstance that a pawl rests on top of the ball and that there is friction between ball and pawl. This results in larger response tolerances.

Attaining a binary sensor effect, i.e. having the inertia part stay either in the one or in the other state, has so far not been achieved to full satisfaction. The standing sensors, too, which generally show better properties than the above-described hanging pendulums, and in particular the inertia ball mounted on a supporting ring, do not produce the desired binary effect if the supporting ring in which the ball rests in many known designs has a truncated cone surface whose cross-section is a straight line. For, at the instant of an accident or in the event of a shock, the ball can always start rolling only when the delay g is greater than the tangent of the angle between the straight line mentioned and the horizontal. This condition is met only when there is a delay so that many known locking devices operate without a binary effect. The ball reacts proportionally, as a function of the last mentioned angle, by exactly the same amount. The binary effect is obtained if the inertia part's center of gravity can be in front of or behind the tilt line.

But there are also standing sensors with inertia parts already which are tiltably suspended so that the binary effect is obtained. Such known inertia parts, however, are costly to manufacture and must be machined with great accuracy on precision lathes. Moreover, the parts machined at relatively high machining expense must be inspected for burrs and deburred, if necessary. Experience shows that when these costly operations are not performed so that the sensor may have a burr, a direction-dependent failure can occur and accuracy losses can result. Due to the possible displacement of the center of gravity it is difficult to deburr the inertia part or to break its edges. Even a small dislocation of the center of gravity or of the bearings due to deburring can lead to great changes in sensitivity and, hence, to an accuracy loss.

Accordingly, it is an object of the invention to improve the inertia-dependent sensor described at the outset so as to permit good response within the desired sensitivity range while retaining the binary effect upon being moved and yet be producible cheaply and simply as well as be relatively insensitive to corrosion and changes in the outer surfaces.

Summary of the Invention

In accordance with this invention, there is provided an inertia dependent sensor having an inertia part retained in a supporting part so as to be freely movable on a ring fixed to a housing, and with a pivotably mounted trigger arm, movable by the inertia part, to release or lock safety members, in particular for motor vehicles, characterized in that the inertia part is retained on the supporting ring so as to be tiltable about a line and has an opening to receive a holding pin projecting out of the inertia part and into the hole in the supporting ring. Preferably, the inertia part is a ball and the sensor is part of a locking mechanism for a seat belt retractor.

According, to the invention, the above problem is solved in that the inertia part is retained so as to be tiltable about a line on the supporting ring and has an opening to receive a holding pin projecting out of the inertia part and into the hole in the supporting ring. This holding pin keeps the inertia part in place above the supporting ring and yet permits tilting about the line mentioned or about a point, considering the direction of the acting acceleration. This causes the new sensor to tilt without having to turn first. It is also of advantage in this design that, after tilting starts, the inertia part begins to slide a little over the ring surface. This sliding friction suppresses the vibrations after they occur, but not before, as is the case with the above-described inertia balls. In other words, the measures according to the invention achieve a binary effect so that the inertia part is either in the one position such as its normal position above the supporting ring, or in the other position such as its position tilted out of the ring after the action of an acceleration at the instant of an accident. Due to this desired binary effect the new inertia-dependent sensor does not react nervously; the above-described brief sliding motion suppresses undesired vibrations.

It is of particular advantage if, in accordance with the invention, the inertia part is a ball. In this embodiment it is expedient for the opening in the inertia part to be a central hole going all the way through it; for the holding pin to project out of the hole at one end in the form of mushroom-shaped head part and at the other end in the form of a truncated cone, the largest diameter of the truncated cone equaling the diameter of the hole in the supporting ring; and for a hemispherical surface attached to the trigger arm to be disposed above the head part of the holding pin. Particularly when, according to another preferred embodiment of the invention, the radius of the hemispherical surface is shallower than that of the head part of the holding pin, the trigger arm can be pivoted without friction losses upon tilting of the inertia part so that its forward tip, for example, can engage the teeth of a gear such as of a flywheel or tripping gear.

The holding pin, preferably consisting of plastic, can advantageously be fitted firmly in the hole extending through the center of the inertia part. The largest diameter the holding pin truncated cone projecting at the lower end is approximately at the level of the supporting ring, preferably slightly below the circle about which the inertia part is tiltable. Due to the truncated cone of the holding pin projecting into the hole in the supporting ring, the inertia part is generally held stable in its normal position, although tilting of the inertia part about the said line or fulcrum point is possible after the action of a shock or the like, the truncated cone permitting a motion of the holding pin in the supporting pin hole.

What the mushroom-shaped attachment, i.e. the head part of the holding pin with the hemispherical outer surface projecting out of the upper end of the inertia part hole achieves, is according to the invention, that the inertia part advantageously no longer has direct friction contact with the trigger arm, but that two hemispherical surfaces of different radii are in sliding contact. Therefore, only these two surfaces need be checked for their sliding properties. It has proved to be particularly expedient for the head part of the holding pin to be made also of plastic so as not only to reduce friction, but also eliminate damage to the hemispherical trigger arm surface. In addition, a holding pin so designed provides the great advantage that the inertia part no longer has to be machined in the costly and disadvantageously accurate manner. It is even possible to produce the sensor body by pressure diecasting. Contamination or small deformations have as little adverse effect on triggering with the desired sensitivity as has corrosion. The considerable advantages resulting from making the inertia part a pressure diecasting according to the invention are clear to those skilled in the art.

One particularly purposeful embodiment is characterized in that the metal ball is flattened on both ends next to the through hole and that the supporting ring has a torus. The above-mentioned tilting line results from placing the lower flat of the pressure diecast ball on the torus.

Another purposeful embodiment is designed so that the metal ball is flattened at its lower end next to the through hole and that the supporting ring has a flat ring surface which, in normal position, is parallel to this flat. While the metal ball rests in normal position on a plane ring surface, at the moment of shock action at the instant of an accident, however, it tilts about a line or a fulcrum point again.

In another embodiment the supporting ring has two ring surfaces of truncated cone shape expanding upwardly which form a circular line protruding towards the inertia ball. Here, the desired tilting line for the attainment of the binary effect is formed at the circle of intersection of two truncated cones.

In another embodiment it is expedient for the metal ball to be flattened at least at its lower end next to the through hole, according to the invention, and for the supporting ring to have an upwardly expanding ring surface of truncated cone shape. Thought is given here to the possibility of forming the supporting ring by one truncated cone only, as in many other known designs, but attaining the line contact for improved tilting of the inertia part in that the metal ball is flattened at its lower end.

The measures according to the invention permit advantageous actions without great expense. For example, it is easy to move the inertia part's center of gravity to another point by changing its shape without thereby impairing the tilting action. Corrosion of the inertia part affects its sensitivity but little, because the sensor is triggered mainly by tilting. The upper end of the holding pin can be of very smooth and even design, resulting in very little friction between the trigger arm and the sensor body. No special deburring is required and, representing another important advantage because there is little room for a wide tilting angle, is the fact that the sensor body need not be disposed inside a housing. Due to the use of plastics at the contact points between two components moving relative to each other, the new sensor according to the invention also works much more quietly because no longer do two metal parts hit each other, such as trigger arm and inertia member.

Brief Description of the Drawings

Other advantages, features and possible applications of the present invention ensue from the specification below of preferred embodiments in connection with the drawings in which

Figure 1 shows schematically and partly in cut-away view the transverse section of the inertia part with its mounting and the trigger arm,

Figure 2 shows the same view as in Figure 1, except in another embodiment in which the ball, flattened at the bottom, is disposed on a flattened seat,

Figure 3 shows another embodiment of the sensor where the ball is round at the bottom and sits on a circular ring, and

Figure 4 shows the same schematic view, partly in section, where the ball is flattened at the bottom and sits in a conical seat.

Description of the Preferred Embodiments

The inertia part 1, in the form of a metal ball, is retained in and freely movable on a supporting ring 2 fixed to the housing, while a trigger arm 4 is mounted on top so as to pivot about an axis 41.

In the embodiment of Figure 1 the inertia ball is flattened at both ends and the supporting ring 2 has a torus 21, in circular line contact, as it were, with the lower flat 12.

The inertia part 1 has, as the opening, a central hole 11 going all the way through it, in which hole a plastic holding pin 3 is inserted. The upper end of the holding pin 3 is a mushroom-shaped head part 31 with a hemispherical outer surface projecting from the top of the inertia ball 1. At the bottom, the holding pin 3 projects in the form of a truncated cone 32, the largest diameter D of which is slightly smaller than the inside diameter of the hole 22 in the supporting ring 2. The truncated cone 32 tapers down towards the outside and ends a little below the supporting ring 2.

Disposed on the trigger arm 4 between the pivot axis 41 and the forward tip 42, which can engage a ratchet wheel not shown, is a hemispherical surface 43 of a radius shallower than that of the head part 31.

It is evident from Figure 1 that when a shock is exerted from the left on the supporting ring 2 fixed to the housing, the inertia ball 1 will move due to inertia to the left into the position of the left circular arc 1′, the mushroom-shaped head part 31 moving at the same time into the left position shown in broken lines. This causes the trigger arm 4 to be moved from the position shown in solid lines to the position shown in broken lines. Analogously, the same applies also to the supporting ring 2 experiencing a shock form the right in Figure 1, the inertia ball 1 then tilting in the opposite direction. The total possible tilt angle is clearly evident from Figure 1.

In Figures 2 to 4, identical parts have the same reference numerals.

The inertial ball 1 in Figure 2 is flattened at its lower end only, next to the through hole 11 so that this flat 12 is the bearing surface with which the inertia ball 1 rests on the plane ring surface 23 of the supporting ring 2. Since the inertial ball 1 is not flattened at its upper end, the mushroom-shaped head part 31 of the plastic holding pin 3 projects somewhat further than in the embodiment according to Figure 1. But otherwise the function is the same as in Figure 1, i.e. when the inertia ball 1 tilts to the left about the point 24, the holding pin 3 will also tilt into the position shown in dash-dotted lines, made possible not least by the design of the truncated cone 32.

In the embodiment according to Figure 3 the inertia ball 1 is flattened neither on the top nor at the bottom, but the circular line contact between the supporting ring 2 and the inertia ball 1 comes about by the inner truncated cone-shaped ring surface 25 intersecting the outer, flatter, truncated cone-shaped ring surface 26 in a line. The circular line 27 resulting therefrom supports the inertia ball 1. It is in this manner that the above-described, advantageous tilting with binary effect is assured again.

If it is desired to design the supporting ring 2 with a simpler cone 28 instead of with two truncated cone-shaped ring surfaces such as 25 and 26 in Figure 3, the embodiment according to Figure 4 can be used. Here, the inertia ball 1 is provided with a flat 12 at its bottom only, which flat intersects the spherical surface of the inertia ball 1 along the line 24′. This line lies on the upwardly expanding, truncated cone-shaped, ring surface 28 so that the advantageous operation according to the invention is possible again.

CLAIMS

1. Inertia-dependent sensor with an inertia part retained in a supporting part so as to be freely movable ona ring fixed to a housing, and with a pivotably mounted trigger arm, movable by the inertia part, to release or lock safety members, in particular for motor vehicles, characterized in that the inertia part is retained on the supporting ring so as to be tiltable about a line and has an opening to receive a holding pin projecting out of the inertia part and into the hole in the supporting ring.

2. The sensor according to claim 1, characterized in that the inertia part is a ball.

3. The sensor according to claim 2, characterized in that the opening in the inertia part is a central hole extending completely through the ball; that a mushroom-shaped head part of the holding pin projects out of the hole at one end and a truncated cone of the holding pin projects out of the hole at the other end, the largest diameter of the truncated cone being equal to or smaller than the hole in the supporting ring; and that a hemispherical surface attached to the trigger arm is disposed next to the head part of the holding pin.

4. The sensor according to claim 3, characterized in that the radius of the hemispherical surface is shallower than that of the head part of the holding pin.

5. The sensor according to claim 4, characterized in that the inertia part is a pressure diecasting.

6. The sensor according to claim 4, characterized in that the inertia part is flattened at both ends next to the hole and that the supporting ring has a torus.

7. The sensor according to claim 4, characterized in that the inertia part is flattened at its lower end next to the hole and that the supporting ring has a plane ring surface lying parallel to this flat in normal position.

8. The sensor according to claim 4, characterized in that the supporting ring has two upwardly expanding ring surfaces in truncated cone shape which form a circular line projecting towards the inertia part.

9. The sensor according to claim 4, characterized in that the inertia part is flattened, at least at its lower end next to the hole and that the supporting ring has a ring surface expanding upwardly in truncated cone shape.

10. The sensor according to claim 4, characterized in that the holding pin is formed of plastic.

11. An inertia-dependent sensor constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

12. A seat belt retractor including a sensor as claimed in the appendant claim.

New claims or amendments to claims filed on 25.11.81.
Superseded claims 12.
New or amended claims:-

12. A seat belt retractor including a sensor as claimed in any preceding claim.

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