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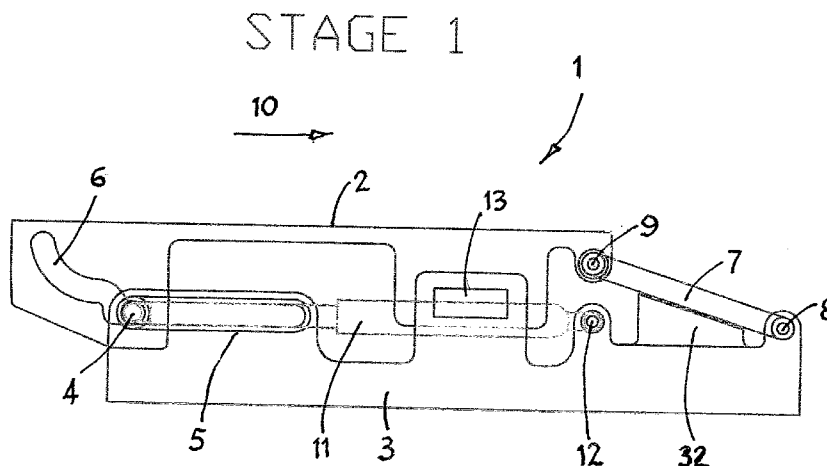
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(54) Title: IMPACT REDUCER



(57) Abstract: An impact reducer (1) for use in a train or coach comprises a mechanism to mount a seat on a base (3), which mechanism includes a connection that upon impact causes the seat first to tilt backwards, by means of the back of the seat dropping downwards and/or the front of the seat lifting upwards, and a connection that allows forward movement of the seat, with an energy absorbing means (11) linked to forward movement of the seat.

FIELD OF THE INVENTION

This invention lies in the field of impact reduction, applied to reducing the effect of impacts on individuals, for example in the context of vehicle collisions, however, the invention may also be applied to reducing the effect of impact on articles, for example delicate instruments or cargoes being transported.

BACKGROUND

Public transport such as coaches, buses and trains usually don't provide protection for seated passengers such as seat belts and air bags, which are used in cars. Recently crumple zones, long used in cars, have been introduced in passenger coaches so as to absorb the energy more gradually in the event of a front-end collision with the intention of reducing the harm done to passengers. However, this measure can only introduce an improvement of limited degree and passengers still travel forward at the original traveling speed while the coach comes to what is still a sufficiently abrupt halt to cause injuries. Passengers are therefore thrown forward with resulting serious injuries in most cases and even death. Seat belts are not provided in the case of trains apparently because the custom became established of seeing trains as more relaxed environments in which people can move about freely. In cars the three-point seat belt and air bags have taken protection of passengers in the event of an accident to a new level, but ongoing improvement is still looked for considering the high cost to society resulting from car accidents. Aircraft do provide seat belts but many aircraft crashes are so severe that seat belts do not save lives. The invention is applicable in all these various types of vehicles to a greater or lesser extent, as will become apparent below. Although the primary focus is to the saving of lives and injury to persons, the invention can have benefits in the transport of articles, especially for example fragile articles that require protection from large G forces in certain directions and the invention is not excluded from application in such areas.

THE INVENTION

An impact reducer for a vehicle in accordance with this invention comprises a mechanism by which a seat or other support is mounted on a base, which mechanism includes a connection that upon impact causes the seat first to tilt backwards, by means of the back of the seat dropping downwards and/or the front of the seat lifting upwards, and a connection that allows forward movement of the seat, with an energy absorbing means linked to forward movement of the seat.

The connection for forward movement and the connection for tilting may be one mechanism, adapted to provide both functions.

Many mechanically equivalent mechanisms can achieve the required integers of the invention and some examples of these are described in what follows. For convenience of description reference will generally be made to a seat for a person or persons.

The mechanism connection that allows forward movement of the seat may comprise one or more of a slide, groove or slot in which a follower, pin or shaft works, one in the seat and the other in the base, so that the one can slide in the other allowing the seat to move forward. The mechanism connection that causes the seat to tilt backwards may comprises slots or mechanical equivalents that are inclined downwards, for the back of the seat, or upwards, for the front of the seat, the slots having pins or equivalent that slide in them. The mechanism connection that causes the seat to tilt backwards may alternatively or additionally comprise links that swing when the seat moves forwards either to drop the back of the seat or raise the front of the seat, or both. Both slides and links can be employed in one impact reducer.

The design of the impact reducer is thus in its first aspect to change the attitude of the seat in which it is normally horizontal or close to horizontal to an attitude in which it is tilted backwards so as to reduce the tendency for a person to slide off the seat when it decelerates upon an impact occurring and instead to tend to settle the person more securely in the seat. The back rest is not the focus of the invention, however, if restraining means, for example seat belts, including the three point seat belts, these

should be secured to the seat, if significant forward movement is provided for upon impact.

The second key aspect of the invention, the energy absorber, is designed to absorb energy as the seat moves forward, so as to bring the seat to a halt progressively over the distance that the seat moves forward upon an impact occurring. This reduces the forces acting on the body of the person as compared to a sudden or near instantaneous stop where the forces can become enormously great, so as to avoid serious injury or death. The energy to be absorbed will vary according to the combined mass of the seat and the passenger, the latter obviously varying according to the passenger. The energy to be absorbed will also vary according to the speed of the vehicle concerned at the moment of impact. The rate of energy absorption with displacement of the seat must be proportional to the product of the speed and the total mass of seat and passenger, that is, the momentum of seat and passenger. Since the mass of the seat is a constant the range of masses resulting from persons of different mass that must be catered for is reduced. The product of speed and mass is the momentum of the seat and passenger and this must be absorbed by the energy absorber by the work done over the distance that the seat moves after impact, being the product or integral of the resistance over this distance. Energy absorption can typically be provided by dry frictional effects or viscosity effects, the latter for example in hydraulic dampers or "shock absorbers" as used in suspension systems, duly modified for this purpose or purpose designed viscous dampers. Both frictional and viscous effects can be applied in the mechanism.

The range of possibilities that must be catered for is wide, for example a child that weighs 25kg may have to be brought to a halt from 40 km per hour and a man that weighs 135 kg may have to be brought to a halt from 360 km per hour and every scenario in between, however the mass of the seat being added to that of the passenger moderates this wide range. To cater for this the energy absorber must preferably be adjustable and this can be achieved through various known devices. The adjustment must be automatic by weighing the combined weight of the seat and person sitting on it and by measuring the speed at any given instant. The weight and speed can be achieved by suitable devices that are known and the measures of weight and speed then transferred to adjust the energy absorption rate. In general the viscosity of the liquid used in a damper can be varied, as in rheological liquids, the dimensions of

apertures used through which the liquid is forced when absorbing energy and there may be other practical means.

Frictional means may include brake pads that are pressed to clamp between them a sliding surface so as to cause a braking effect or energy absorption by friction. The pressure by which the pads press against the sliding surface can be adjusted according to passenger weight and/or speed. Weight adjustment can be simple, using suitable linkages to transfer weight of passenger and seat to pressure on the pads, for example.

Certain applications can have space restrictions that limit tilting and/or forward movement, examples are likely in motor cars and in passenger airplanes. In these applications the distance of tilting and of forward sliding may have to be limited by suitable design of the mechanism. For example, in a car the tilting may be achieved by dropping the back of the seat only, having very little or no raising of the front of the seat, to avoid the person's legs engaging the dashboard. Forward sliding may be limited or even reduced to a very small distance, relying mostly on tilting to improve the protection of the passenger against impact effects. Energy absorption may be provided against the dropping down of the back of the seat and optionally the small forward movement.

THE DRAWINGS

The invention will be more fully described by way of examples, with reference to the drawings, in which : -

Figure 1A is a schematic side view of an impact reducer, in rest position,

Figure 1B is a schematic side view of the impact reducer in an initial position upon an impact occurring,

Figure 1C is a schematic side view of the impact reducer in a final position after an impact,

Figure 1D is a schematic side view of the components of the impact reducer shown in figures 1A to 1C.

Figure 2A is a schematic side view of an impact reducer, of another embodiment, in rest position,

Figure 2B is a schematic side view of the impact reducer in an initial position after an impact,

Figure 2C is a schematic side view of the impact reducer in a latter position after an impact,

Figure 2D is a schematic side view of the impact reducer after a rearward directed impact has occurred,

And

Figure 2E is a schematic side view of the components of the impact reducer shown in figures 2A to 2D.

THE PREFERRED EMBODIMENTS

In figure 1A the impact reducer is shown in its normal or rest position before an impact. The impact reducer 1 comprises a mechanism which in this example includes a platform 2 by which a seat or other support is mounted in a vehicle (not shown) on a base 3 which is fixed rigidly to the vehicle structure. The mechanism includes a pin or shaft 4 that passes through both a slot 5 in the base and a slot 6 in the platform and a link 7 that pivotally connects the base at 8 to the platform at 9. This connection allows forward movement of the seat in the direction indicated by arrow 10 and causes the seat to tilt backwards, by means of the back of the seat dropping downwards and the front of the seat lifting upwards, when the seat moves forward. An energy absorbing hydraulic damper 11 is linked to the platform at position 4 and to the base at position 12, which absorbs energy during forward movement of the seat. A magnet 13 located

on the base engages the platform while the impact reducer in a “rest” condition before an impact, thus serving as a stabilizer for the platform and seat. The energy absorption only commences after the seat has tilted and once the pin 4 starts to slide along the slot 5, as will be appreciated from the description of the drawing. This is important to ensure that the person is in the best position – on a tilted seat – to be retained on the seat, when deceleration commences, during deceleration the tilting inclination increases.

When an impact occurs the stabilizer, which may be an electromagnet, releases the platform, to allow the forward movement. The stabilizer may alternatively be a mechanical type, such as a catch or hook that normally engages the platform but made frangible to the right degree so that it fractures upon an impact occurring, for example. Hydraulically and pneumatically actuated systems could also be used.

Figure 1B shows the initial stage reached after an impact, the platform carrying the seat and passenger has dropped down at the back by means of the pin 4 sliding along the slot 6 as indicated by arrow 14 and the platform and seat carrying the passenger has lifted up at the front by means of the link swinging as indicated by arrow 15. These movements result in the seat tilting backwards wedging the passenger more firmly in the seat. No deceleration of the platform, seat and passenger has been brought about by the energy absorber at this stage.

Figure 1C shows the final stage reached after an impact, the platform, seat and passenger have moved forward as the pin 4 slides in the slot 5 and the link continues to swing to the position shown, increasing the lifting of the front of the seat and hence the tilt of the seat. This increases the tendency to keep the passenger in the seat. While this happens the energy absorber is absorbing energy so as to bring the seat progressively and gradually to a halt. The energy absorber is shown as a hydraulic damper, or “shock absorber” but it may be a specialized kind that has a means of varying its degree of resistance and hence level of energy absorption. An example is a magneto-rheological type of shock absorber. Mechanically adjustable shock absorbers are also available and servo motors could be used to adjust these according to the momentum that must be absorbed.

In figure 2A the impact reducer is shown in its normal or rest position before an impact. The impact reducer 16 comprises a mechanism which in this example includes a platform 17 by which a seat or other support is mounted in a vehicle (not shown) on a base 18 which is fixed rigidly to the vehicle structure. The mechanism includes a pin or shaft 19 that passes through both a slot 20 in the base and a slot 21 in the platform and a link 22 that pivotally connects to the base at 23 and to the platform by means of the pin 24 that can slide in track 25.

This connection allows both forward movement of the seat in the direction indicated by arrow 26 and rearward movement of the seat as indicated by the arrow 27. This embodiment of the invention is adopted when the seats are to be installed in a train for example, facing both forwards and rearwards. An energy absorbing hydraulic damper 28 is linked to the platform at position 13 and to the base at position 29, which absorbs energy both during forward and rearward movement of the seat. A stabilizer which may be a magnet 30 is located on the base and engages the platform while the impact reducer in a "rest" condition before an impact, thus serving as a stabilizer for the platform and seat. When an impact occurs the magnet, which is an electromagnet, releases the platform, to allow the forward movement. From the position shown the shock absorber 28 can both extend and contract, the former for an impact when the platform is facing rearward and the latter when the platform is facing forward.

Figure 2B shows that when an impact occurs, the magnets release the platforms and impact reducers that are facing forwards allow the platform and the seat mounted on it to move in the direction indicated by the arrow 26. Initially this movement results in the rear of the platform and seat moving downwards due to the slot 21 moving until the pin 19 is in the position shown in figure 2B and in the front of the platform and seat lifting upwards as the link 22 swings in the direction indicated by arrow 31 to the position shown in figure 2B. During this initial stage of the movement of the platform and seat there is no energy absorption and no deceleration of the platform and seat.

Figure 2C shows that from the position reached in figure 2B the platform and seat continue to move in the direction indicated by arrow 26 with the pin 19 sliding to the forward end of the slot 20 and the link 22 continuing to swing and reaching the position shown in figure 2C. The inclination of the platform and seat increases and the

shock absorber absorbs energy during this phase bringing the platform and seat to a gradual halt.

Figure 2D shows that when an impact occurs, the impact reducers that are facing rearwards allow the platform and the seat mounted on it to move in the direction indicated by the arrow 27, a horizontal movement without any tilting of the platform and seat. The person is supported by the backrest of the seat while the shock absorber brings the platform and seat to a gradual halt, absorbing energy as it extends.

As will be apparent to the ordinary workman in the art there are other mechanical arrangements that would achieve the equivalent effects and these are covered also by the scope of this patent. The platform and base indicated are mere examples but they must be fitted with sliding action or slots or links arranged to provide the tilting action of the seat, for seats facing forwards. The platform and base may be provided in pairs, one on each side of the seat, with one or two shock absorbers and will be engineered with sufficient strength for their duty. The design must in all cases result in the first response to an impact being the tilting of the seat, preferably before the energy absorption begins to decelerate the seat. Non-adjustable shock absorbers can be used and would be the most economical, the variation of momentums, the product of speed and mass, to be encountered would most likely be graphed as a bell curve. By adopting a shock absorber that is suited to the central region of the curve most circumstances would be catered for with the fringes representing only a smaller number of cases. Adjustable shock absorbers can be hydraulic, pneumatic, electromagnetic and magneto-rheological, for example. Adjustment of the viscosity of a magneto-rheological fluid can be controlled by a weight detector in the platform and a speed sensor so as to adjust the viscosity to be proportional to the momentum of the platform, seat and passenger. It is possible that a reliable and consistently performing mechanical system can be developed using dry friction effects using the advantage that the load on the friction surfaces would be inherently proportional to the weight of the platform, seat and person, a speed controlled force would be added to provide the appropriate response to the speed component of momentum. The link that lifts the front end of the platform and seat must initially be at an angle to the horizontal, for example as seen in figures 1A and 2A and is held in these "rest" positions by the blocks 32 for this reason. In a train installation each carriage could be fitted with its

own control system, that would be an impact sensor that controls electrical current to the stabilizer magnets, to release the platforms on the instant of an impact. The carriage would also have a speed sensor that sends a speed signal to all the seats. On each seat a weight sensor would detect total mass and the product of the mass and speed would be fed to the magneto-rheological shock absorbers to adjust the deceleration rate according to the speed and mass on each seat.

The mechanism can be modified to provide for the energy absorber to be oriented in use upright or nearly so, if desired or required. If required the mechanism can be adapted to absorb energy also when the seat is tilting backwards, in an appropriate proportion of the total energy that is required to be absorbed. A simplified design can be based on an assumed maximum energy absorption required, for example on a bell distribution curve a maximum mass of passenger of 90 kilograms and a maximum speed at impact of 180 km per hour, that being the maximum of a particular train in which the apparatus is to be used. A speed value can then be set as one that is still acceptable in that it will not cause serious injury if stopped instantly. The energy absorbing means can then be set to absorb energy arising (with the seat mass included) at impact to reduce speed to the non-injury-causing speed for the assumed maximum mass and speed. Any impact reduction from lesser factors than these will then just bring the seat and person to a halt more quickly than the available total travel of the mechanism. Such a simplified system can use a frictional or viscous energy absorption means that is fixed in this way to a compromise level.

Trains, coaches and buses seem to be the most apt applications for the invention, but in principle it may be adapted to other vehicles, such as aircraft and passenger cars, allowing for suitable adaptation to the more limited space for forward movement and tilting action.

CLAIMS

1. An impact reducer for a vehicle which includes a mechanism by which a seat or other support is mounted on a base, which mechanism includes a connection that upon impact first causes the seat to tilt backwards, by means of the back of the seat dropping downwards and/or the front of the seat lifting upwards, and a connection that then allows forward movement of the seat, with an energy absorbing means linked to forward movement of the seat.
2. An impact reducer for a vehicle as claimed in claim 1, in which the connection for forward movement and the connection for tilting are one mechanism, adapted to provide both functions.
3. An impact reducer for a vehicle as claimed in either one of claims 1 or 2, in which an energy absorbing means is linked to tilting of the seat.
4. An impact reducer for a vehicle as claimed in any one of claims 1 to 3, in which the mechanism connection that allows forward movement of the seat includes a slide in which a follower works, one in the seat and the other in the base, so that the one can slide in the other allowing the seat to move forward.
5. An impact reducer for a vehicle as claimed in claim 3, in which the mechanism connection that causes the seat to tilt backwards includes a slide that is inclined downwards, for the back of the seat, or upwards, for the front of the seat, or both, the slide having a follower that slides in it.
6. An impact reducer for a vehicle as claimed in either one of claims 4 or 5, in which the mechanism connection that causes the seat to tilt backwards includes a links that swings when the seat moves forwards either to drop the back of the seat or raise the front of the seat, or both.

7. An impact reducer for a vehicle as claimed in any one of claims 1 to 6, in which the rate of energy absorption with displacement of the seat is proportional to the product of the speed and the total mass of seat and passenger.
8. An impact reducer for a vehicle as claimed in any one of claims 1 to 7, in which the energy absorption is provided by dry frictional effects.
9. An impact reducer for a vehicle as claimed in any one of claims 1 to 8, in which the energy absorption is provided by viscosity effects.
10. An impact reducer for a vehicle as claimed in any one of claims 1 to 8, which is adapted for both forward and rearward impact absorption, which includes a rearwardly extended slide with a follower located in an intermediate position in the slide in a rest position before any impact occurs.
11. An impact reducer for a vehicle as herein described and as illustrated in figures 1A to 1D of the drawings.
12. An impact reducer for a vehicle as herein described and as illustrated in figures 2A to 2D of the drawings.
13. An impact reducer for a vehicle which includes a mechanism by which a seat or other support is mounted on a base, which mechanism includes a connection that upon impact causes one or more actions selected from the seat tilting backwards, by means of the back of the seat dropping downwards and/or the front of the seat lifting upwards, and forward movement of the seat, with an energy absorbing means linked to tilting and/or forward movement of the seat.
14. An impact reducer as claimed in claim 13, in which the mechanism causes the back of the seat to drop downwards with energy absorption, the front

of the seat to lift very little and the seat to slide forward very little, with energy absorption.

AMENDED CLAIMS
received by the International Bureau on 4 January 2010 (04.01.10)

1. An impact reducer for a vehicle comprising a mechanism by which a seat or other support is mounted on a base, which mechanism includes a first pin and slot or link connection that upon impact first causes the seat to tilt backwards by means of the back of the seat dropping downwards, and a second pin and slot or link connection that also causes the seat to tilt backwards by means of the front of the seat lifting upwards, characterized in that the first pin and a third slot provide a connection that then allows forward movement of the seat, with an energy absorbing means linked to said first pin to absorb energy during forward movement of the seat.
2. An impact reducer for a vehicle as claimed in claim 1, in which the mechanism connection that allows forward movement of the seat includes a slide in which a follower works, the follower in the seat and the slide in the base, so that the one can slide in the other allowing the seat to move forward.
3. An impact reducer for a vehicle as claimed in claim 2, in which the mechanism connection that causes the seat to tilt backwards includes a slide that is inclined downwards, for the back of the seat, or upwards, for the front of the seat, or both, the slide having a follower that slides in it.
4. An impact reducer for a vehicle as claimed in claim 1, in which the mechanism connection that causes the seat to tilt backwards includes a links that swings when the seat moves forwards either to drop the back of the seat or raise the front of the seat, or both.
5. An impact reducer for a vehicle as claimed in any one of claims 1 to 4, in which the rate of energy absorption with displacement of the seat is proportional to the product of the speed and the total mass of seat and passenger.

6. An impact reducer for a vehicle as claimed in any one of claims 1 to 5, in which the energy absorption is provided by dry frictional effects.
7. An impact reducer for a vehicle as claimed in any one of claims 1 to 6, in which the energy absorption is provided by viscosity and/ or pneumatic effects.
8. An impact reducer for a vehicle as claimed in any one of claims 1 to 7, which is adapted for both forward and rearward impact absorption, which includes a rearwardly extended slide with a follower located in an intermediate position in the slide in a rest position before any impact occurs.
9. An impact reducer for a vehicle as herein described and as illustrated in figures 1A to 1D of the drawings.
10. An impact reducer for a vehicle as herein described and as illustrated in figures 2A to 2D of the drawings.
11. An impact reducer as claimed in claim 1, in which the mechanism causes the back of the seat to drop downwards with energy absorption, the front of the seat to lift very little and the seat to slide forward very little, with energy absorption.

FIGURE 1A

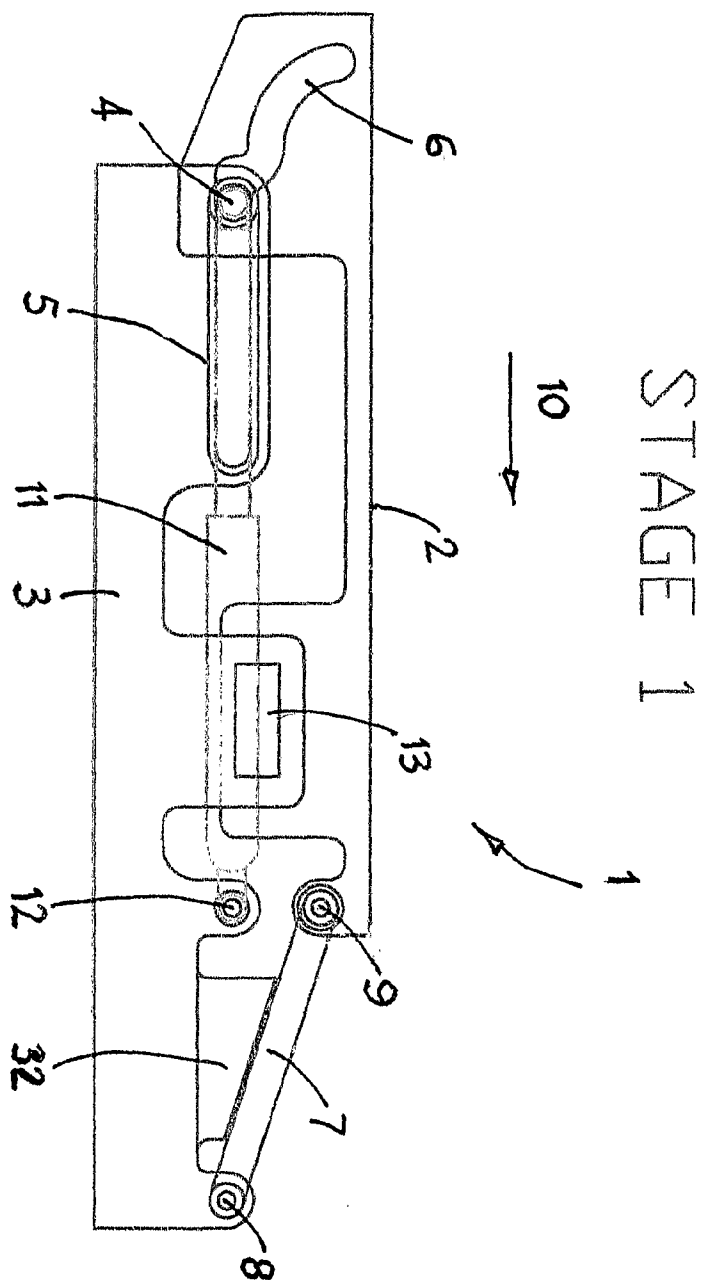


FIGURE 1B

STAGE 2

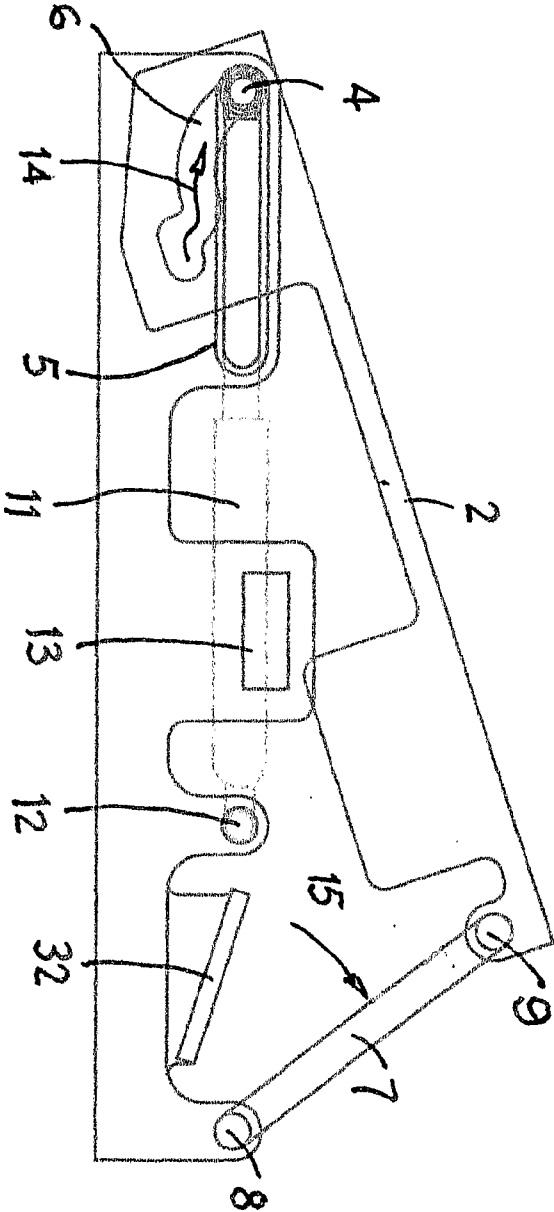


FIGURE 1C

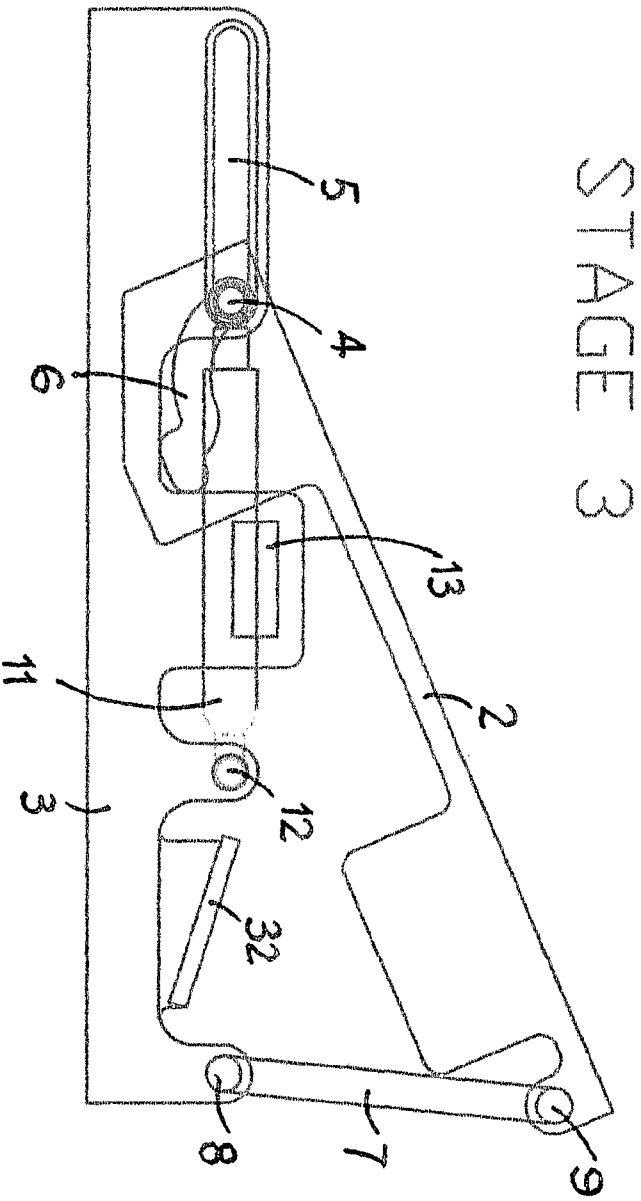


FIGURE 1D

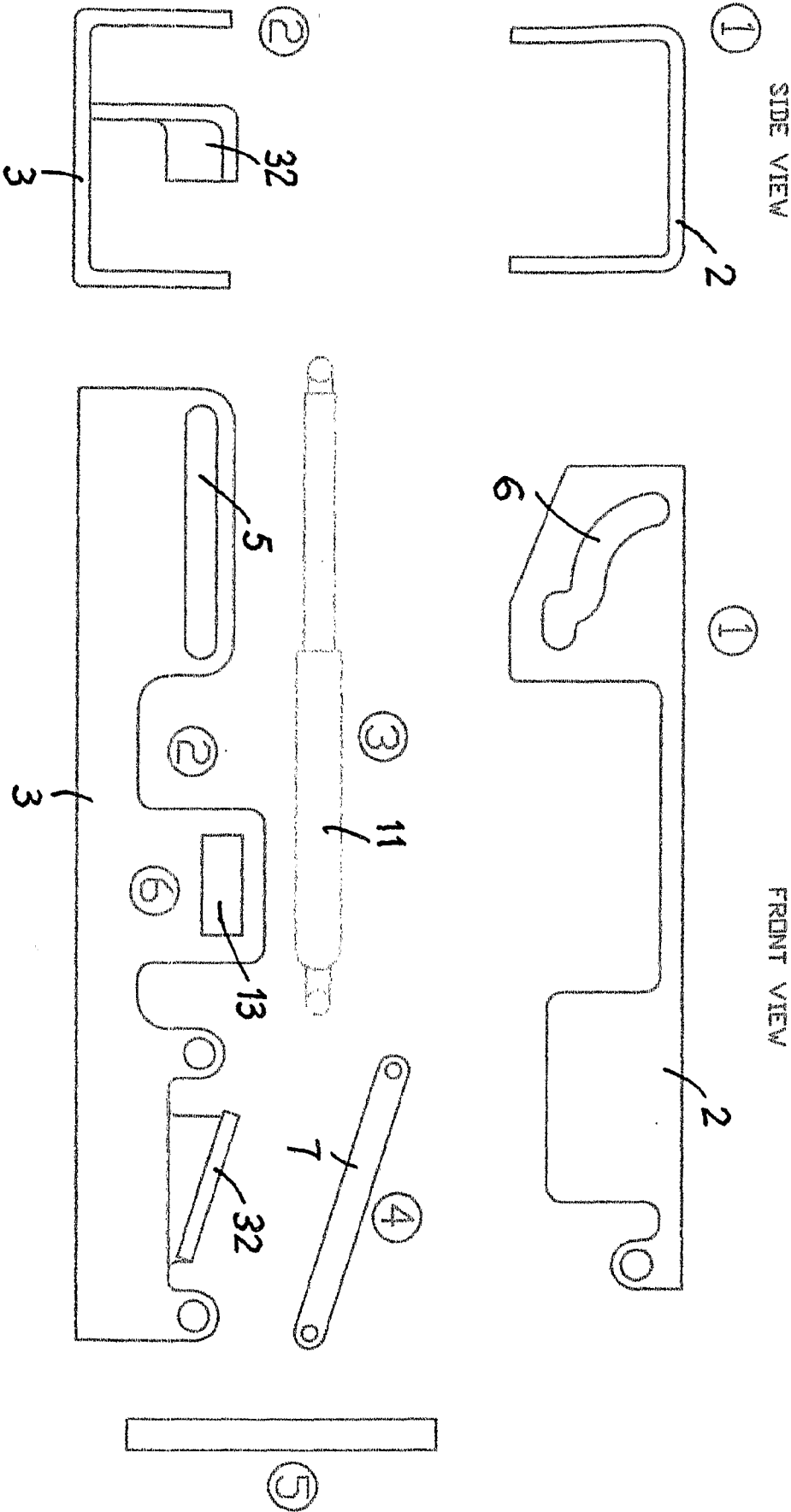


FIGURE 2A

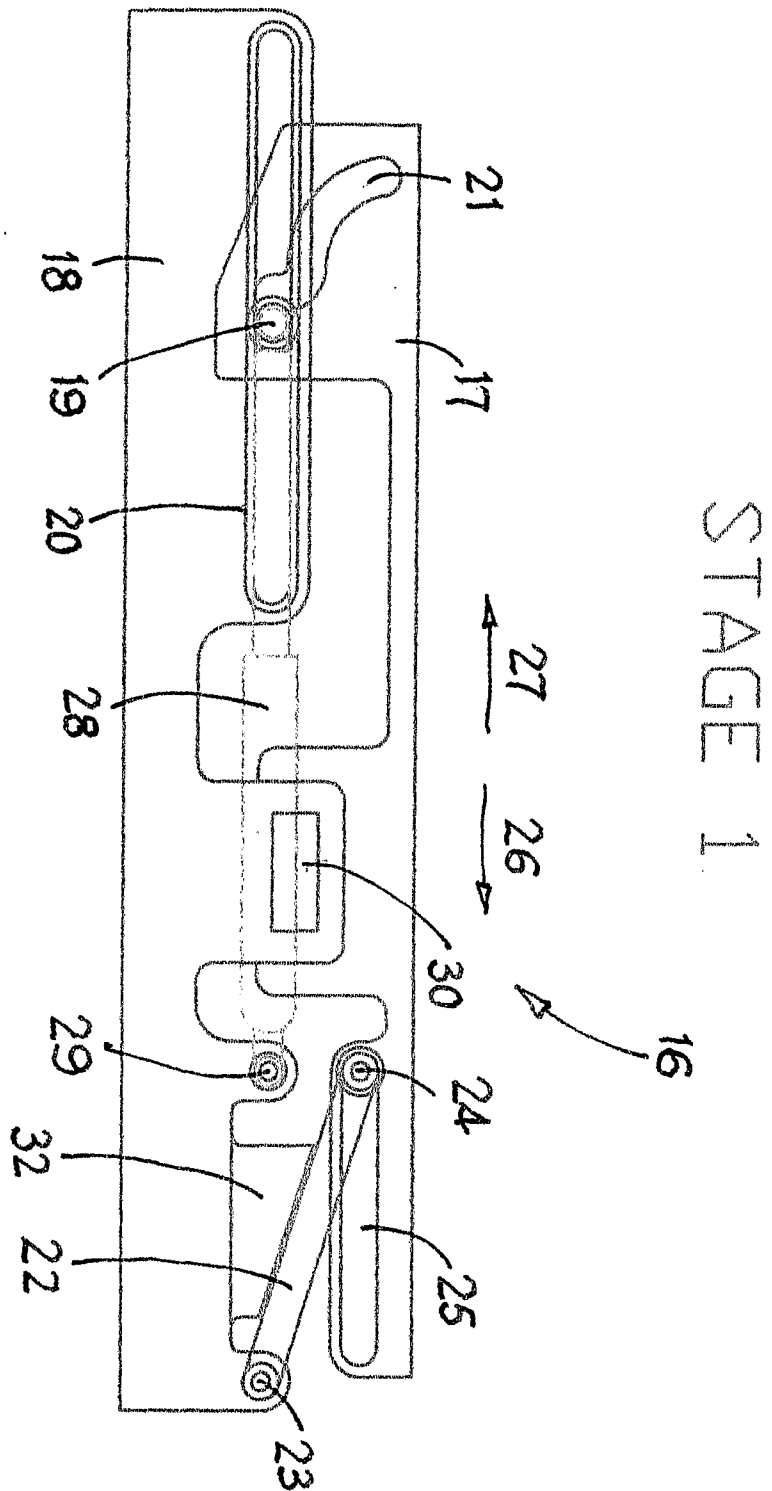


FIGURE 2B

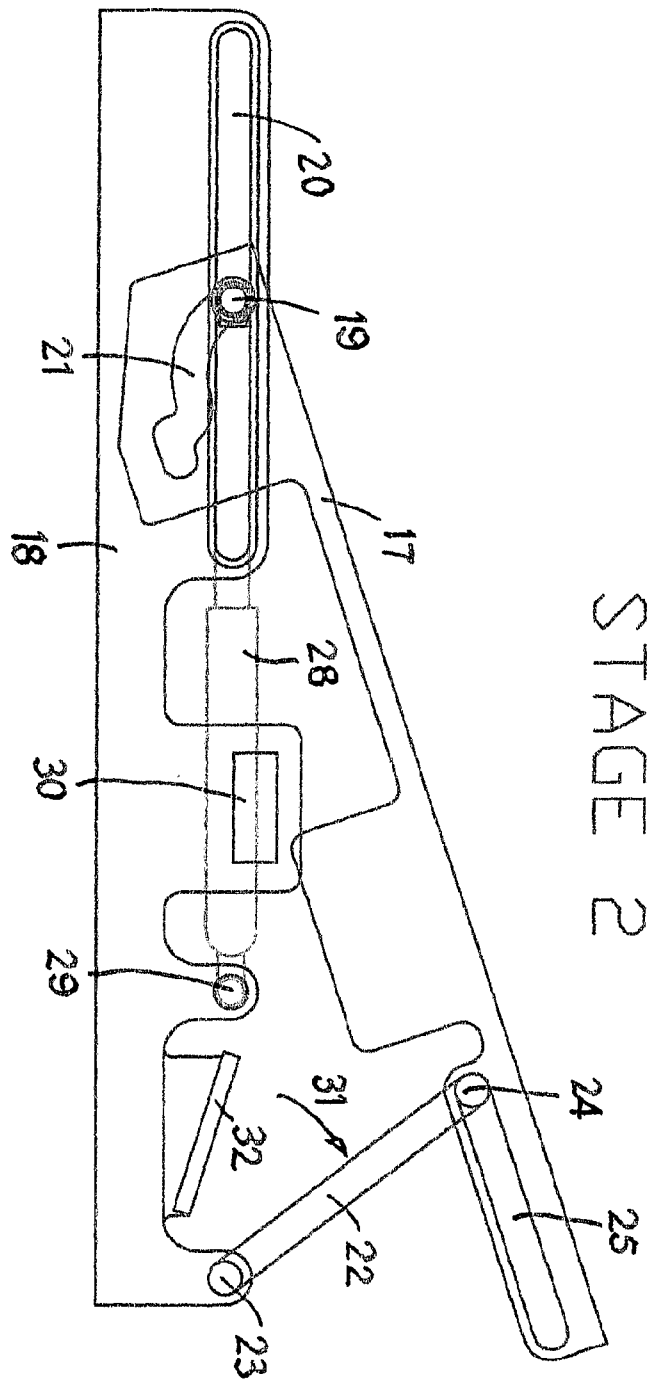


FIGURE 2C

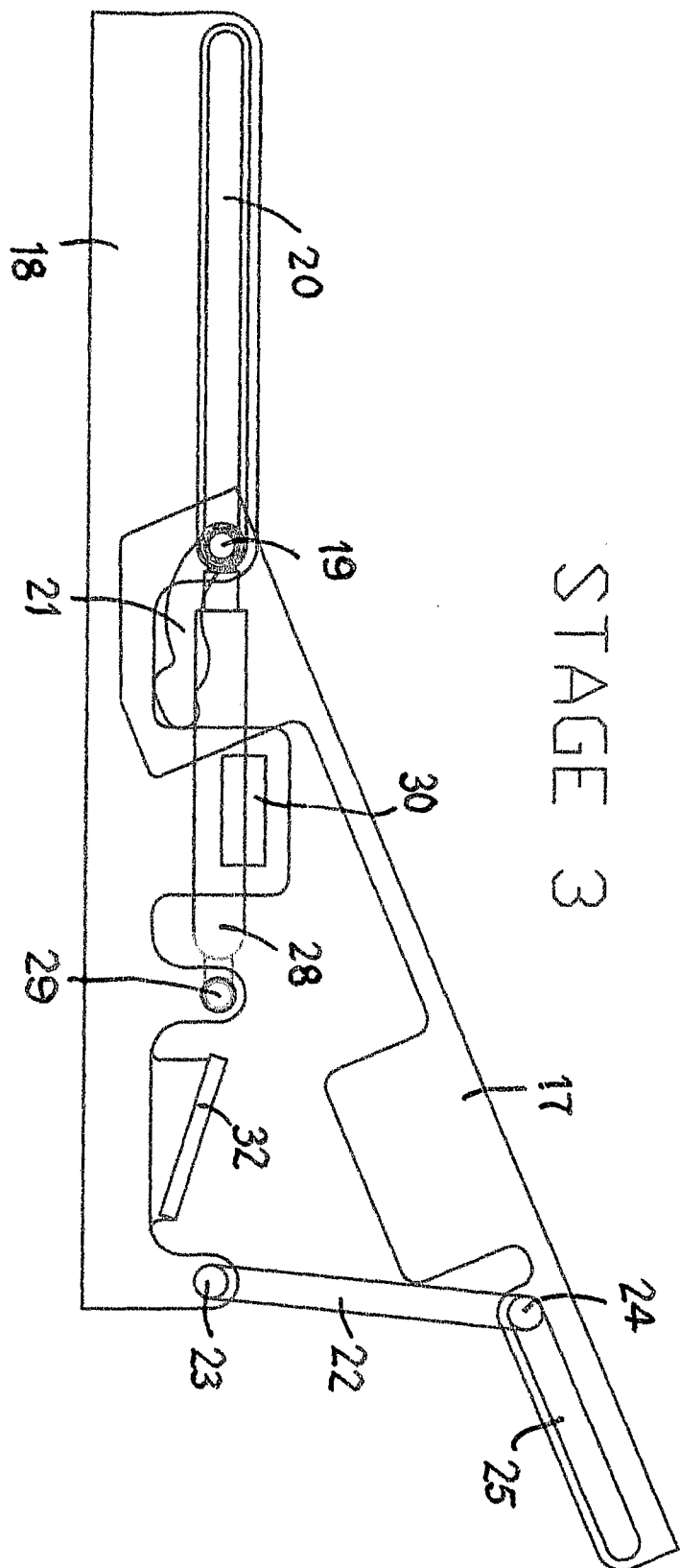


FIGURE 2D

STAGE -1

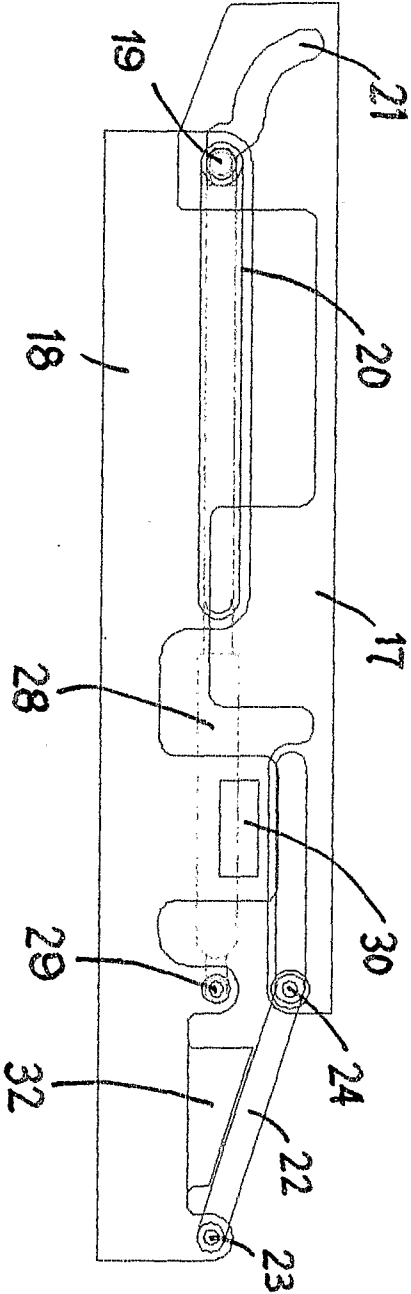
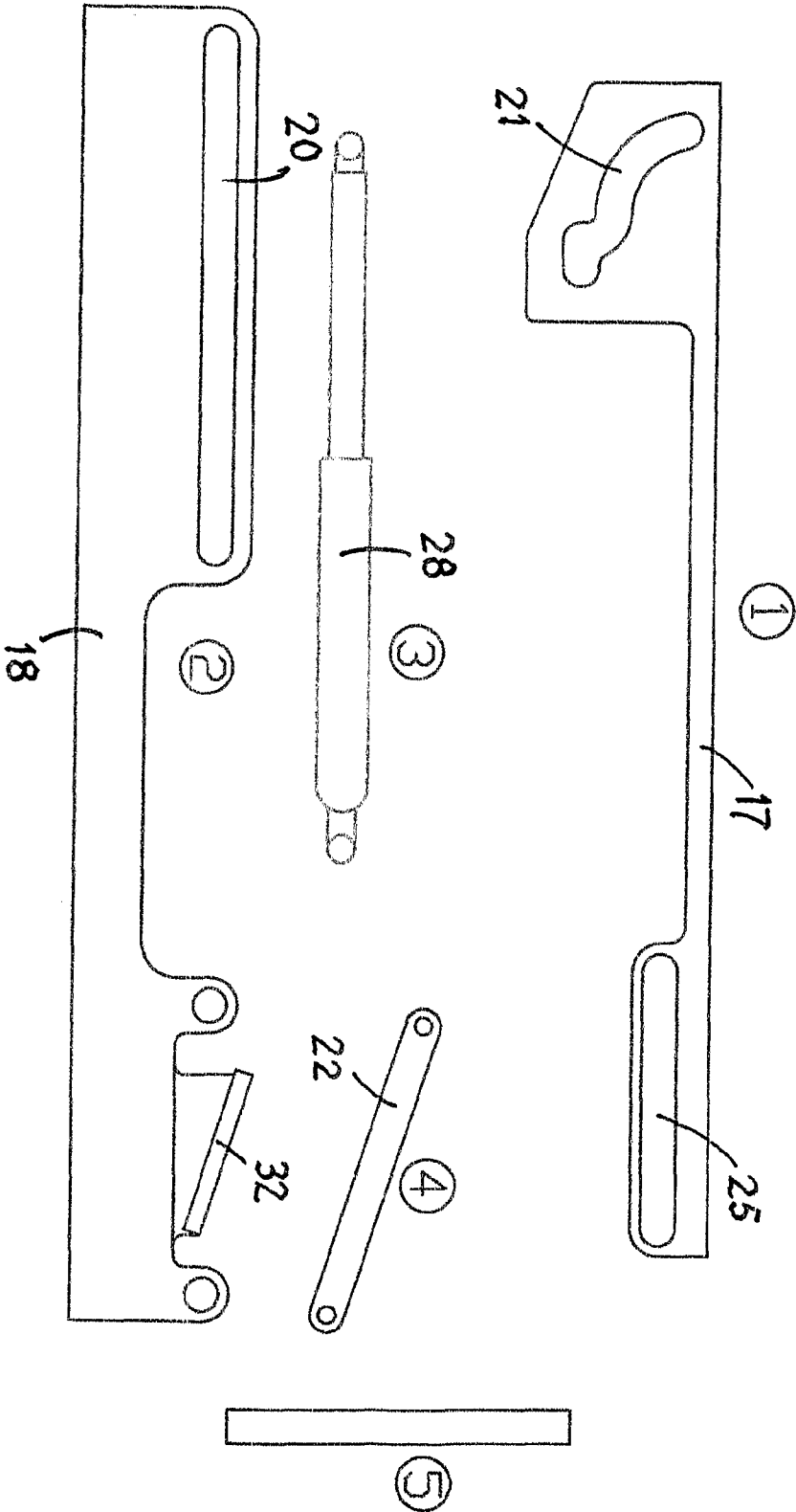


FIGURE 2E



INTERNATIONAL SEARCH REPORT

International application No.
PCT/ZA 2009/000050

A. CLASSIFICATION OF SUBJECT MATTER IPC⁸: B60N 2/427 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) IPC⁸: B60N 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) EPODOC, WPI, TXTE, TXTG		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 998 291 A (DAVIS) 21 December 1976 (21.12.1976) <i>whole document</i>	13
Y	--	1-4, 6
Y	US 2 970 862 A (RACINE) 7 February 1961 (07.02.1961) <i>column 2, line 72 - column 3, line 10; column 5, lines 44 - 56, figs. 2-4</i>	1-4, 6
X	US 3 357 736 A (MC CARTHY) 12 December 1967 (12.12.1967) <i>figs 2-8, description col. 3-8</i>	13
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "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 "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "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 12 November 2009 (12.11.2009)		Date of mailing of the international search report 9 December 2009 (09.12.2009)
Name and mailing address of the ISA/ AT Austrian Patent Office Dresdner Straße 87, A-1200 Vienna Facsimile No. +43 / 1 / 534 24 / 535		Authorized officer RABONG G. Telephone No. +43 / 1 / 534 24 / 463

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PCT/ZA 2009/000050

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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DE	A	2333498		DE	A1	2333498	1975-01-23
WO	A	1990009905		none			