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(71) Applicant: BREED AUTOMOTIVE TECHNOLOGY, INC. [US/US]; P.O. Box 33050, Lakeland, FL 33807–3050 (US).

(72) Inventors: PETTYPIECE, Robert, Perry, Jr.; 2170 Rainbower Court, Lakeland, FL 33810 (US). STEMBLER, Edward, Ronald; 4706 Price Avenue, Tampa, FL 33611 (US).

(74) Agents: DRAYER, Lonnie, R.; Breed Automotive Technology, Inc., P.O. Box 33050, Lakeland, FL 33807–3050 (US) et al.

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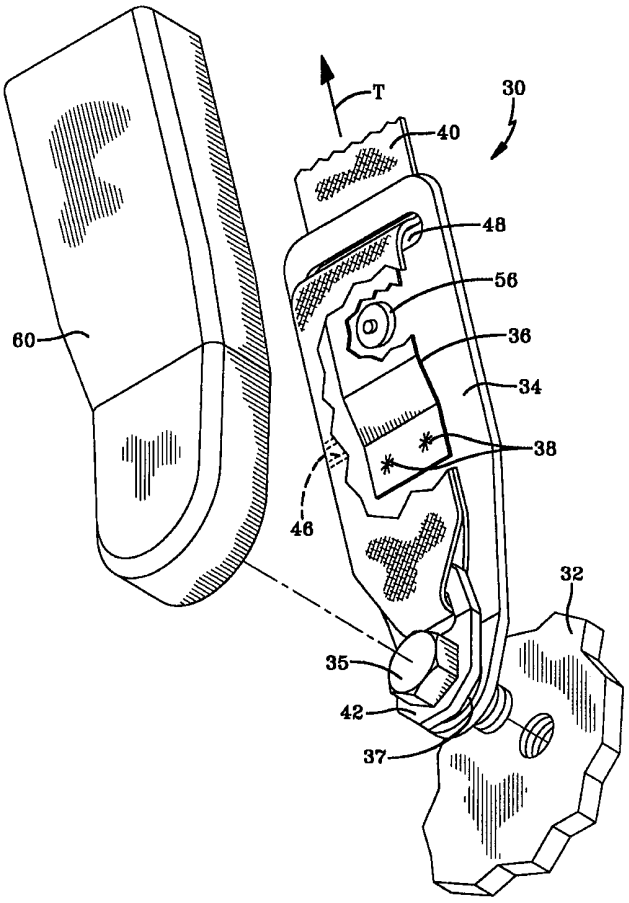
(54) Title: APPARATUS TO MEASURE SEAT BELT TENSION

(57) Abstract

Tension in a seat belt is evaluated by a device which has a rigid member (34) retained in a fixed orientation with respect to a structural member (32) of a vehicle. A resilient member (36) is attached to the rigid member with a force sensitive electrical device (56) disposed between the rigid member and the resilient member. When the seat belt is subjected to tension it presses against the resilient member which in turn exerts a force on the force sensitive electrical device. Preferably, the force sensitive electrical device is in circuit communication with a device which processes a signal from the force sensitive electrical device to evaluate the tension on the seat belt.



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APPARATUS TO MEASURE SEAT BELT TENSION

The present invention relates to an apparatus for evaluating tension in a seat belt of the type employed in a motor vehicle.

In the field of safety devices for motor vehicle occupants there has been considerable interest in developing devices to determine the weight supported by the seat cushion of a vehicle seat and in devices for detecting the presence of an infant or child seat on a vehicle seat. It has been observed that if the seat belt used to secure an infant or child seat to a vehicle seat is cinched too tightly the associated weight sensing device in the vehicle seat may detect a weight greater than the actual wight of the infant or child seat and the infant or child it contains.

An apparatus for evaluating tension in a seat belt in accordance with the present invention can either: (a) directly enable or disable the activation of a vehicle occupant safety device; or (b) provide an additional input signal to the weight sensing device, and/or a device controlling the activation of vehicle occupant safety devices, indicating the amount of tension on a seat belt associated with a seat. The weight sensing device, and/controller, may process this input to compensate for excessive force transferred through the seat cushion to the force sensing assembly as a result of excessive seat belt tension on an infant or child seat.

EP 0 721 863 A2 teaches an apparatus for detecting whether an infant or child seat is mounted on a vehicle seat employing eight variable resistance pressure sensors in the seat cushion to determine the total weight supported by the seat cushion and the

weight distribution. This apparatus may be used in conjunction with seat belt fastening detection to indicate when a seat is occupied and the seat belt is not fastened.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may take physical form in certain parts and arrangement of parts, a preferred embodiment of which will be described in detail in this description and illustrated in the accompanying drawings which form a part hereof and wherein:

Fig. 1 is a diagrammatic representation of a prior art vehicle seat with a child seat secured thereto by a prior art seat belt;

Fig. 2 is an exploded fragmentary perspective view of an apparatus for evaluating tension in a seat belt according to an embodiment of the present invention;

Fig. 3 is a front elevation view, partially broken away, of the embodiment of Fig. 2;

Fig. 4 is a side elevation view, in section along line 4-4 of Fig. 3, of the embodiment of Fig. 2; and

Fig. 5 is a side elevation view, in section of an alternative embodiment of an apparatus for evaluating tension in a seat belt according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to Fig. 1, there is shown a diagrammatic representation of a prior art vehicle seat having a seat cushion 10 and a seat back 12 with a conventional infant or child seat 14 secured thereby a conventional seat belt. A conventional seat lap belt has two lengths 16, 18 of seat belt material separately linked together by a buckle 20. Typically one of the lengths of seat belt material is secured to an anchor 22 which is retained in a fixed orientation with respect to a structural member of a vehicle by a means for attachment 24, such as screws, bolts, rivets, welding and so forth. An occupant sensing apparatus 26 is located in the seat cushion 10 to sense the weight supported by the seat cushion. One example of such a weight sensing apparatus is taught in US 5 494 311 which discloses a film having an electrical characteristic with changeable states and a contact member. When the vehicle seat is occupied, the contact member pushes on the film and changes the state of the electrical characteristic. An electric circuit is connected to the film for providing signals relating to seat occupant presence, weight and position.

The device for sensing the weight supported by the seat cushion may communicate with a device controlling the activation of vehicle occupant safety devices such as airbags and seat belt pretensioners. It has been observed that while such devices may be capable of determining the weight of a vehicle seat occupant satisfactorily in most circumstances, erroneous results may be obtained when an infant or child safety seat is located on a seat equipped with

such a weighing device. There is a limit on the amount of tension on a lap belt, or the lap portion of a three point safety belt, which can be comfortably tolerated by the flesh of a human seat occupant. However, an infant or child seat which is made of a plastic material can tolerate a higher amount of tension from a lap belt, or the lap portion of a three point safety belt, employed to secure the infant seat or child seat to a vehicle seat. This excessive seat belt tension on the infant or child seat may result in excessive force being transmitted through the seat cushion to a seat force sensing device used for weighing a seat occupant. It follows that the device used for weighing a seat occupant may therefore communicate to a device controlling the activation of vehicle occupant safety devices that the seat is occupied by an occupant that weighs more than the actual combined weight of an infant, or child, seat and the associated infant, or child.

Referring next to Figs. 2-4 there is shown in Fig. 2 an exploded fragmentary perspective view of an apparatus for evaluating tension in a seat belt according to an embodiment of the present invention, with Fig. 3 being a front elevation view, partially broken away, of the embodiment of Fig. 2, and Fig. 4 being a side elevation view, in section along line 4-4 of Fig. 3, of the embodiment of Fig. 2. An apparatus 30 for evaluating tension in a seat belt has a rigid member 34 retained in a fixed orientation with respect to a structural member 32 of a vehicle. The structural member of a vehicle may extend at any angle with respect to the floor of the vehicle and may for example be a floor member of a vehicle, a pillar member of a vehicle, or a substantially vertically

oriented seat supporting member of a vehicle. It is understood that the angular orientation of the rigid member 34 may be adjusted to compensate for its location in a vehicle and the configuration of the seating of a vehicle. The rigid member 34 is retained in a fixed orientation by any suitable fastening means such as a bolt 35, riveting, welding and so forth.

A resilient member 36 is attached to the rigid member 34. In the embodiments illustrated herein the resilient member is a metallic spring which is attached to the rigid member by any suitable attachment means such as spot welds 38, bolts or rivets. It is understood that any suitable resilient member may be employed in the disclosed apparatus such as a coil spring, a hinged lever arm, or a compressible structure formed of a polymeric material.

In the embodiment of Figs. 2-4 a first portion 50 of a length of conventional seat belt material 40 is anchored in a fixed orientation with respect to the structural member 32 of the vehicle by looping the seat belt material through an aperture 44 in an anchor member 42 which is in turn fixed in place by the fastening means 35. In this example a washer 37 separates the anchor member 42 from the rigid member 34. The loop in the seat belt material is closed by stitches 46. A second portion 52 of the length of seat belt material 40 is disposed on a side of the resilient member 36 that is distal from the rigid member 34. A third portion 54 of the length of seat belt material 40 extends through an aperture 48 in the rigid member 34. The resilient member 36 is at least partially disposed between the aperture 48 in the rigid member and the first portion 50 of the length of seat belt material. The third portion

extends to a buckle (not shown) that is attached to the length of seat belt material. In the embodiments shown in the drawings the resilient member partially overlaps the aperture to guide the seat belt material into the aperture. A shroud 60 may be fitted to the apparatus for aesthetic purposes and to protect the apparatus from foreign objects and damage.

It is understood that the length of seat belt material 40 may be attached to a second length of seat belt material by a buckle. These two lengths of seat belt material cooperate to act as a lap belt to secure an occupant or an infant or child seat in a vehicle seat in the usual manner. It is further understood that the second length of seat belt material is secured at the end opposite the buckle to a seat belt retractor device and or pretensioner device in the usual manner, and that a third length of seat belt material may be joined to the second length to serve as a shoulder belt in a manner that is well known in the art.

A force sensitive electrical device 56 is disposed between the rigid member 34 and the resilient member 36. In a basic embodiment the force sensitive electrical device 56 is a pressure switch which is in circuit communication, for example thorough leads 58, with a vehicle occupant safety device to enable or disable the activation of a vehicle occupant safety device. Preferably, the force sensitive electrical device is in circuit communication, for example thorough leads 58, with a signal processing device (not shown) which processes a signal from the force sensitive electrical device to evaluate the tension on the length of seat belt material. As used herein and in the claims the term "in circuit communication" is

used to describe (I) devices that are directly or indirectly electrically connected with each other, (ii) devices having other devices or combinations of devices (e.g. breakers, relays, buffers, drivers, transmitters, receivers, and decoders) between them, (iii) devices in optoisolator or fiber optic link, (iv) devices in electromagnetic communication with each other (via, e.g. radio frequency transmitter and receiver pair), (v) devices connected by and through other structures allowing them to communicate with each other, and (vi) any combination of the above.

The force sensitive electrical device may be for example a pressure switch, a strain gauge, a load cell, a magnetostrictive sensor, a capacitive pressure sensor, or a variable resistance pressure sensor. A working prototype of a vehicle seat equipped with an apparatus for evaluating tension in a seat belt in accordance with the present invention employed a sensor which is a Model 14 compression only subminiature load cells purchased from Sensotec, Inc. of 1200 Chesapeake Avenue, Columbus, Ohio U.S.A. This sensor is available with a range of either 45.4 kilograms or 113.5 kilograms. The height of these sensors is 3.8 millimeters.

When tension is placed on the length of seat belt material 40, as shown at T in Fig. 2, when the seat belt is pulled across the lap of a person or to secure an infant or child seat in place, the seat belt material urges the resilient member 36 towards the rigid member and a resultant force is sensed by the force sensitive electrical device 56 which is operatively interposed between the resilient member and the rigid member. In a preferred embodiment the force sensitive electrical device transmits a signal

to a signal processing device with processes the signal, or a series of such signals, to evaluate the tension on the length of seat belt material. The signal processing device can simply evaluate if the tension is below or above a selected threshold, or can be so sophisticated as to determine the actual value of the tension in selected units. The signal processing device may be in circuit communication with a seat occupant weighing device or with a device which controls the activation of vehicle occupant safety devices such as airbags and pretensioners, and can generate signals which are transmitted thereto. Accordingly, the tension is a length of seat belt material detected by an apparatus of the present invention can be factored into a decision as to whether or not a vehicle seat is supporting an infant or child seat that is secured in place by the seat belt.

Referring next to Fig. 5 there is shown a side elevation view, in section of an alternative embodiment of an apparatus 70 for evaluating tension in a seat belt according to the present invention. In this example the rigid member 72 is secured in a fixed relationship with a substantially horizontally extending floor 72 of a vehicle by a bolt 76. A length of seat belt material 76 is looped through two apertures 80, 82 in the rigid member itself, rather than a separate anchor member as in the embodiment of Figs. 2-4. A resilient member 84 and force sensitive electrical device 86 are assembled with the rigid member as described above with regards to the embodiment of Figs. 2-4, and the apparatus functions in the manner described above. Once again a shroud 88 may be fitted to the apparatus for aesthetic purposes

and to protect the apparatus from foreign objects and damage.

CLAIMS:

1. An apparatus for evaluating tension in a seat belt comprising:

(a) a rigid member (34) retained in a fixed orientation with respect to a structural member (32) of a vehicle;

(b) a resilient member (36) attached to the rigid member;

(c) a length of seat belt material (40), a first portion of said length of seat belt material being anchored in a fixed orientation with respect to said structural member of the vehicle, a second portion of said length of seat belt material being disposed on a side of the resilient member that is distal from said rigid member, a third portion of said length of seat belt material extending through an aperture in the rigid member wherein the resilient member is at least partially disposed between the aperture in the rigid member and the first portion of the length of seat belt material, said third portion extending to a buckle that is attached to said length of seat belt material; and

(d) a force sensitive electrical device (56) disposed between the rigid member and the resilient member.

2. An apparatus for evaluating tension in a seat belt according to claim 1 wherein said force sensitive electrical device (56) is a pressure switch.

3. An apparatus for evaluating tension in a seat belt according to claim 1 wherein the force sensitive electrical device (56) is in circuit

communication with a signal processing device which processes a signal from said force sensitive electrical device to evaluate the tension on said length of seat belt material.

4. An apparatus for evaluating tension in a seat belt according to claim 3 wherein said force sensitive electrical device (56) is a strain gauge.

5. An apparatus for evaluating tension in a seat belt according to claim 3 wherein said force sensitive electrical device (56) is a load cell.

6. An apparatus for evaluating tension in a seat belt according to claim 3 wherein said force sensitive electrical device (56) is a variable resistance pressure sensor.

7. An apparatus for evaluating tension in a seat belt according to claim 3 wherein said force sensitive electrical device (56) is a capacitive pressure sensor.

8. An apparatus for evaluating tension in a seat belt according to claim 3 wherein said force sensitive electrical device (56) is a magnetostrictive sensor.

9. An apparatus for evaluating tension in a seat belt according to either of claims 1or 3 wherein said resilient member (36) is a spring.

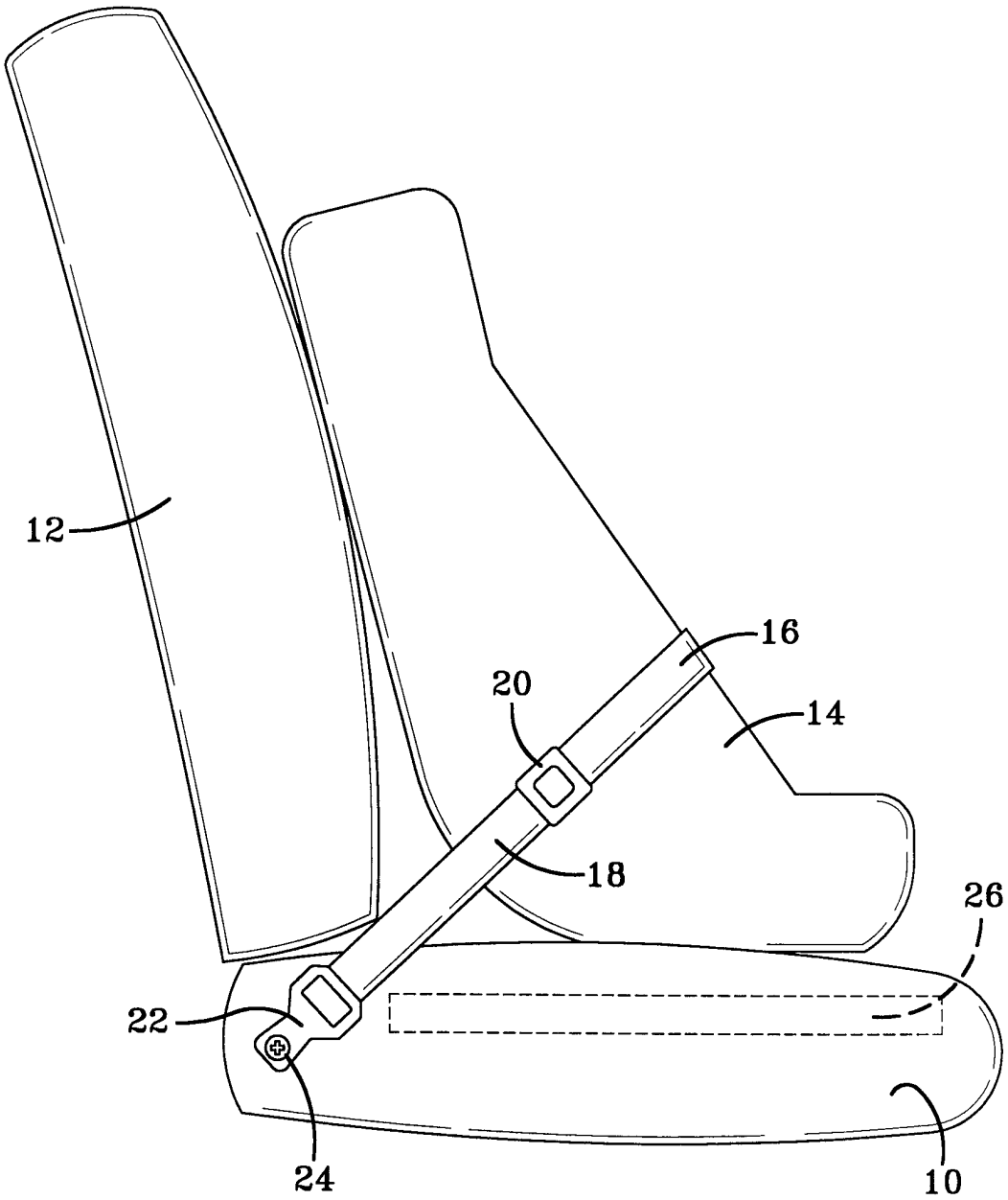

FIG-1
PRIOR ART

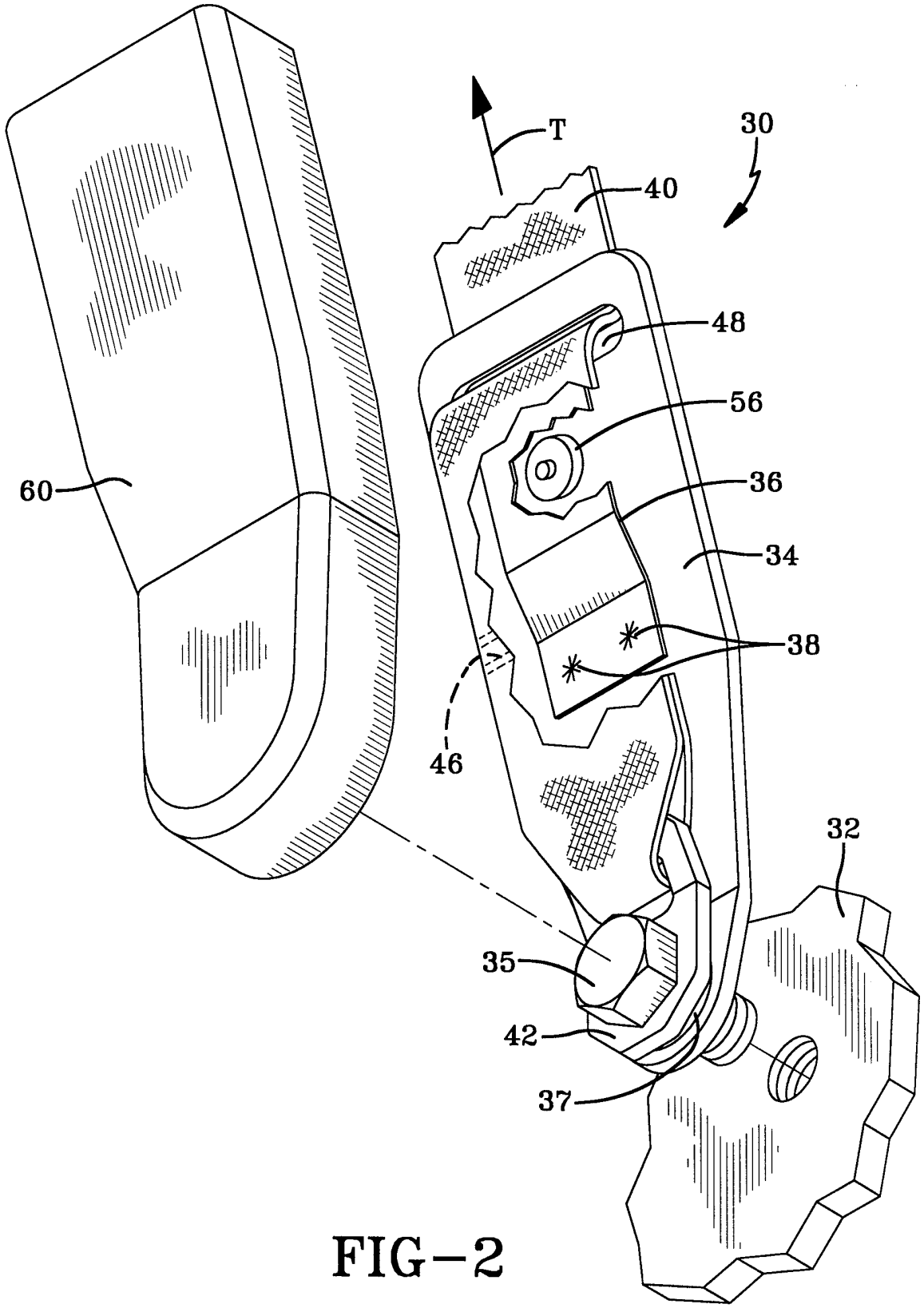

FIG-2

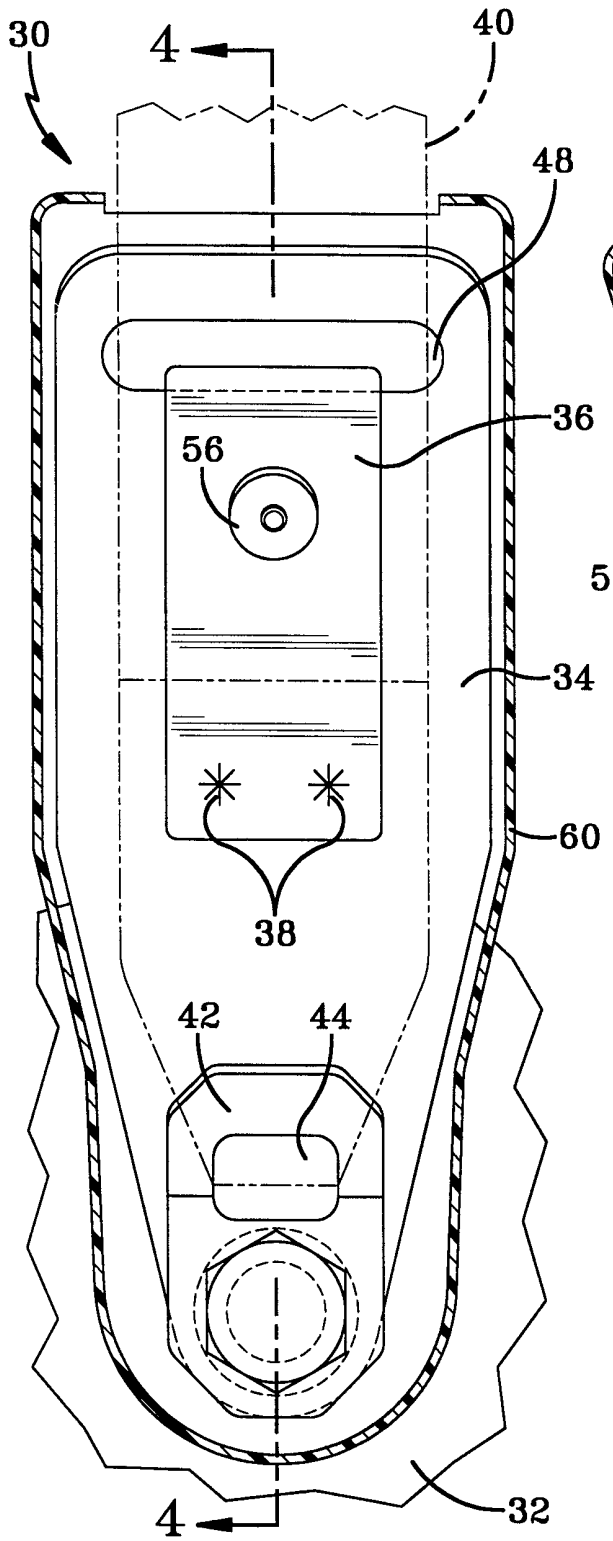
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FIG-3

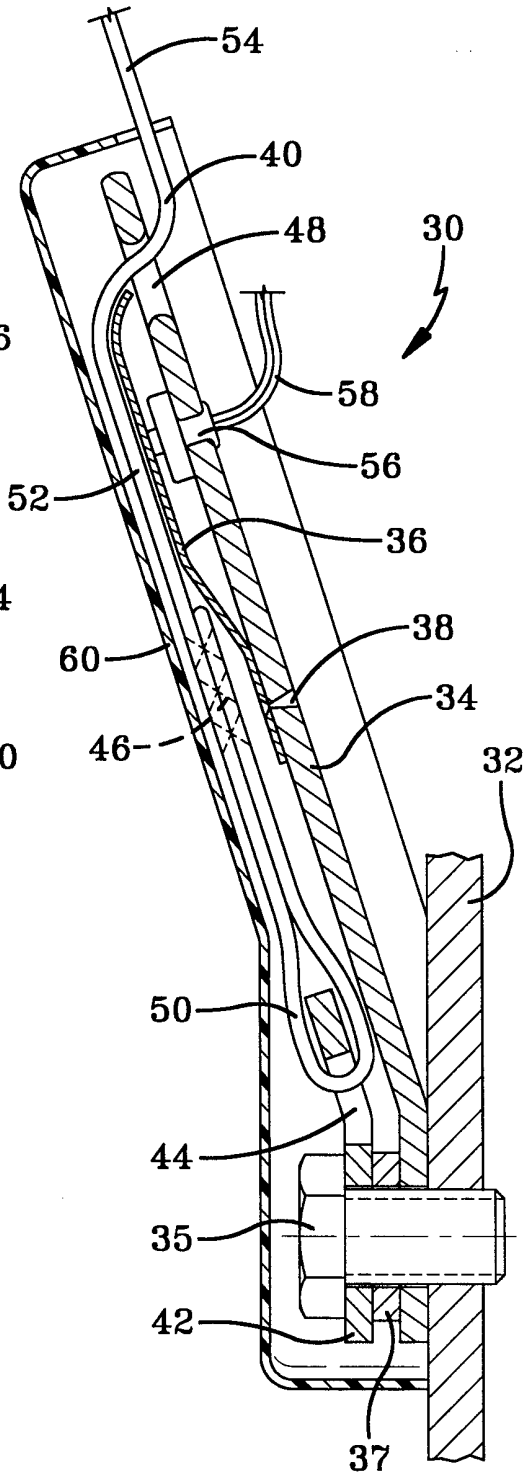
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FIG-4

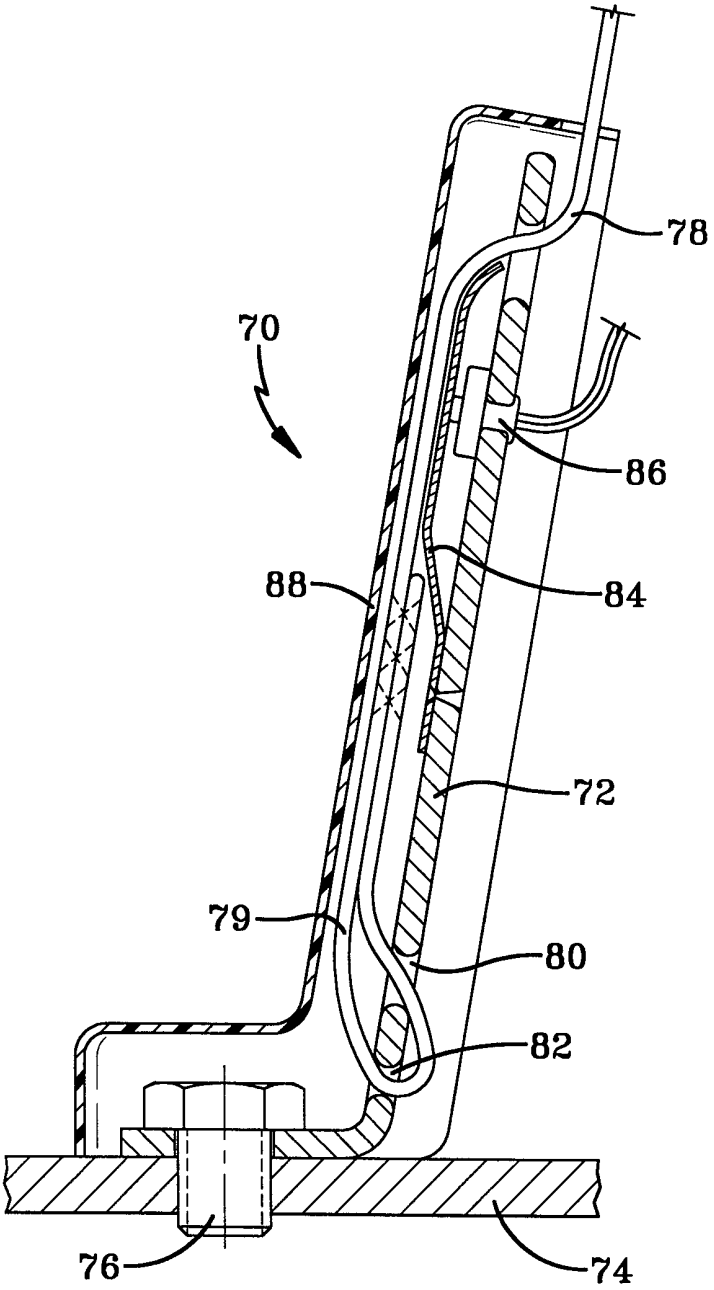

FIG-5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/16837

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G01L 5/04; G011 5/10; B60R 22/44
US CL :Please See Extra Sheet.
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)

U.S. : 73/862.194, 862.391,862.42, 862.451, 862.453, 862.471,862.473, 828

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)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,181,739 A (BAUER et al) 26 January 1993 (26.01.93), see figure 1, elements 20, 24, 50 and col. 5, line 36	1-9
A	US 4,846,000 A (STEINSEIFER) 11 July 1989 (11.07.89), see the entire patent	1-9
A	US 4,805,467 A (BARTHOLOMEV) 21 February 1989 (21.02.89), see the entire patent	1-9
A	US 3,817,093 A (WILLIAMS) 18 June 1974 (18.06.74), see the entire patent.	1-9
A	US 3,176,510 A (KIMMELL) 06 April 1965 (06.04.65), see the entire patent.	1-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

73/862.194, 862.391,862.42, 862.451, 862.453, 862.471,862.473, 828

B. FIELDS SEARCHED
Electronic data bases consulted (Name of data base and where practicable terms used):

APS
search term: tension, test, load, force, pressure, resilient, elastic, plastic, rubber, cpu, processor, computer, inspect, measure