CONVENTION

AUSTRALIA

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NOTICE OF ENTITLEMENT

We, **IDEATECH, INC.** of Suite 101, 9093 Technology Drive, Fishers, Indiana 46038, United States of America state the following in connection with Australian Application No. 24310/92:

1. We are the nominated person.

2. The nominated person is the assignee of the actual inventors.

3. The nominated person is the assignee of the applicants of the basic application listed in the declaration under Article 8 of the PCT.

4. The basic application is the application first made in a Convention country in respect of the invention.

Dated: 21 January 1993

By **PHILLIPS ORMONDE & FITZPATRICK**
Patent Attorneys for the Applicant
By: David B Fitzpatrick

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To: The Commissioner of Patents

PHILLIPS ORMONDE & FITZPATRICK
367 Collins Street
Melbourne, Australia, 3000

Our Ref: 315807

1925x

AU9224310

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AIR BAG DEVICE FOR VEHICLES

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(71) Applicant(s)
IDEATECH, INC.

(72) Inventor(s)
LARRY D HOAGLAND; STEPHEN J BROCKMAN

(74) Attorney or Agent
PHILLIPS ORMONDE & FITZPATRICK , 367 Collins Street, MELBOURNE VIC 3000

(56) Prior Art Documents
US 3966226
US 3913604
GB 1378079

(57) Claim

1. Cushioning apparatus to be mounted in a vehicle having collision sensing means to rapidly generate a signal in response to a collision, said cushioning apparatus being deployed upon collision to protect an occupant in the vehicle from injury and including a reservoir containing prior to collision a pressurized fluid and having an outlet, an inflatable cushion having an inlet and adapted to be inflated solely by said pressurized fluid, a frangible plate supported around the periphery thereof so as to leave the major central area of said frangible plate unobstructed, said frangible plate having an upstream side facing the outlet of the reservoir and a downstream side opposite said upstream side, the frangible plate sealing the outlet of said reservoir and interposed between the outlet of the reservoir and the inlet of the inflatable cushion, and means to permit the pressurized fluid within the reservoir to rupture the frangible plate in response to a signal from said collision sensing means and inflate the cushion, wherein:

the frangible plate rapidly shatters into discrete fragments when struck,

.../2

a striking member is provided adjacent the downstream side of the frangible plate and has a longitudinal axis, a first end to strike the frangible plate and rapidly shatter the frangible plate, a second end opposite said first end, and a transverse cross section substantially smaller than the major central area of the frangible plate,

second means are provided to mount the striking member for movement along its longitudinal axis toward the downstream side of the frangible plate,

third means are provided to rapidly apply a force to the second end of the striking member in response to said signal generated by the collision sensing means to drive the striking member along its longitudinal axis toward the downstream side of the frangible plate so that the first end of the striking member shatters the frangible plate,

a passage generally annularly disposed about the striking member is provided and has area adequate to permit the rapid flow therethrough of pressurized fluid from the reservoir into the inflatable cushion, and

filter means are interposed between the frangible plate and the inlet of the inflatable cushion.

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(71) Applicant: IDEATECH, INC. [US/US]; Suite 101, 9093 Technology Drive, Fishers, IN 46038 (US).

(72) Inventors: HOAGLAND, Larry, D. ; 6314 Peacemaker Lane, Noblesville, IN 46060 (US). BROCKMAN, Stephen, J. ; 180 Charing Cross Court, Noblesville, IN 46060 (US).

(74) Agent: SCHUMAN, Jack; Suite 2600, One Indiana Square, Indianapolis, IN 46204 (US).

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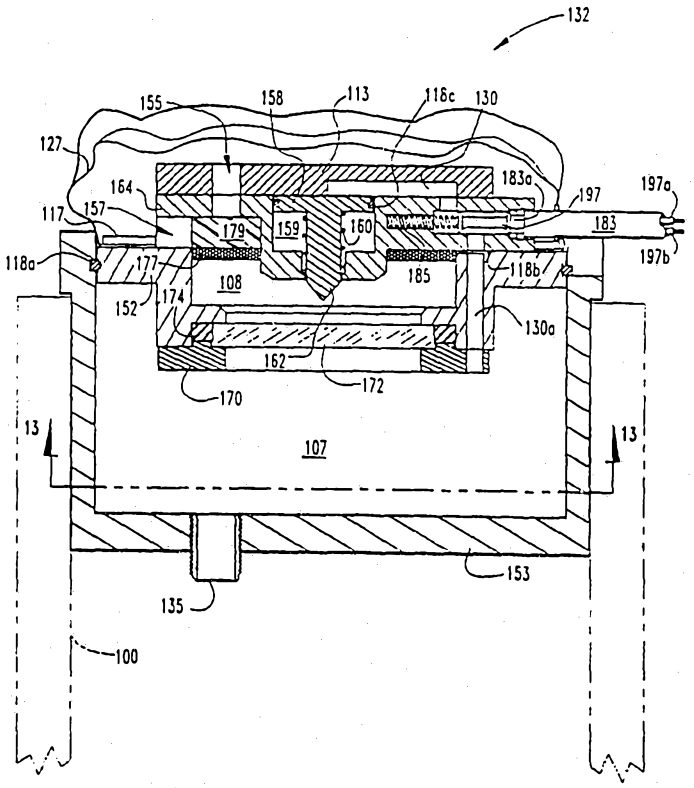
(54) Title: AIR BAG DEVICE FOR VEHICLES

(57) Abstract

An air bag safety device (132) comprises a reservoir of pressurized fluid (153) having an outlet, an inflatable air bag (127) having an inlet, and a frangible plate (172) interposed between the outlet of the reservoir (153) and the inlet of the air bag (127). A collision sensing means generates a signal in response to a collision, causing a striking member (162) to advance and shatter the frangible plate (172), whereupon pressurized fluid flows rapidly from the reservoir (153) to the air bag (127). A filter (177, 179) is generally annularly disposed about the striking member (162) to catch fragments of the frangible plate (172).



AIR BAG DEVICE FOR VEHICLES

TECHNICAL FIELD

The present invention relates in general to a safety device and more specifically to a safety device for use with a vehicle.

With the advent of increasingly faster modes of transportation, vehicle manufacturers have increased the amount of protection afforded by a vehicle, both in the number of safety devices and in the sophistication of each safety device. To further encourage vehicle manufacturers to incorporate safety features in their products, the federal government has often promoted safety legislation which mandates varying degrees of safety for vehicles, including automobiles. Among other such mandates as crash resistant bumpers on automobiles and seat belts for passengers in automobiles, current federal legislation has focused on the incorporation of passive restraint devices in automobiles, one such restraint device being an air bag.

Air bags, as passive restraint devices for automobiles, are inflatable during an automobile accident by a source of pressurized fluid. These devices have generally fallen into two categories; inflation from those expansion processes employing reactive or explosive means for inflating, and inflation from expansion processes involving the liberation of pre-pressurized gases contained within a pressure vessel.

BACKGROUND ART

Air bag devices have been developed which pertain to the latter liberation of gases. Two such devices by Okada, U.S. Patent No. 4,203,616 and U.S. Patent No. 4,289,327 appear to disclose an air bag mechanism with a pre-pressurized canister separated from the air bag by a frangible member. The frangible member is dependent on a pressing lid for support. Upon impact of a vehicle, a mechanism causes the pressing lid to move, thereby allowing pressure within the canister to

rupture the frangible member. Another device by Hirbod, U.S. Patent No. 4,215,878 appears to disclose a bumper-air bag system having three valve mechanisms connected to a vehicle bumper. Movement of the bumper during a collision appears to build up pressure to a level which ruptures a diaphragm and liberates pre-pressurized gasses.

Weman, U.S. Patent No. 3,927,901, appears to disclose a vehicle air bag system with several air bags all interconnected to a pressurized air tank. Impact causes the generation of a pressure wave within the tank which propagates throughout the tank towards the valves and causes the valves to open, thus inflating an air bag. Hodges, U.S. Patent No. 2,755,125, Sandor, U.S. Patent No. 2,931,665, and Lee et al., U.S. Patent No. 4,258,931, all appear to disclose other air bag devices which inflate an air bag using pre-pressurized air stored in a container.

The above described devices rely on either pressure differential to rupture a seal or pressure-activated valves to release pre-pressurized air stored in a pressure vessel. Because both pressure-rupturable seals and pressure-activated valves do not positively release air from a storage container, a need exists for an improved safety device for use with a vehicle that employs a positive release mechanism to release a source of pressurized fluid and inflate an air bag.

DISCLOSURE OF THE INVENTION

A safety device for use with a vehicle is disclosed. The safety device incorporates an inflatable air bag coupled to a source of pressurized fluid. A frangible seal fluidally separates the source of pressurized fluid from the inflatable air bag until a collision occurs. Upon a collision occurring, sensing means for sensing a collision causes mechanical cutting means to positively cut the frangible seal, thereby allowing fluid to flow from the source to the air bag and inflate the air bag.

One object of the present invention is to provide an improved safety device.

Another object of the present invention is to provide an improved safety device for use with a vehicle.

Still another object of the present invention is to

According to an aspect of the present invention, there is provided a cushioning apparatus to be mounted in a vehicle having collision sensing means to rapidly generate a signal in response to a collision, said cushioning apparatus being deployed upon collision to protect an occupant in the vehicle from injury and including a reservoir containing prior to collision a pressurized fluid and having an outlet, an inflatable cushion having an inlet and adapted to be inflated solely by said pressurized fluid, a frangible plate supported around the periphery thereof so as to leave the major central area of said frangible plate unobstructed, said frangible plate having an upstream side facing the outlet of the reservoir and a downstream side opposite said upstream side, the frangible plate sealing the outlet of said reservoir and interposed between the outlet of the reservoir and the inlet of the inflatable cushion, and means to permit the pressurized fluid within the reservoir to rupture the frangible plate in response to a signal from said collision sensing means and inflate the cushion, wherein:

the frangible plate rapidly shatters into discrete fragments when struck,

a striking member is provided adjacent the downstream side of the frangible plate and has a longitudinal axis, a first end to strike the frangible plate and rapidly shatter the frangible plate, a second end opposite said first end, and a transverse cross section substantially smaller than the major central area of the frangible plate,

second means are provided to mount the striking member for movement along its longitudinal axis toward the downstream side of the frangible plate,

third means are provided to rapidly apply a force to the second end of the striking member in response to said signal generated by the collision sensing means to drive the striking member along its longitudinal axis toward the downstream side of the frangible plate so that the first end of the striking member shatters the frangible plate,

a passage generally annularly disposed about the striking member is provided and has area adequate to permit the rapid flow therethrough of pressurized fluid from the reservoir into the inflatable cushion, and

filter means are interposed between the frangible plate and the inlet of the inflatable cushion.

One advantage of the present invention is an improved safety device.

Another advantage of the present invention is an improved safety device for use with a vehicle.

Still another advantage of the present invention is an improved safety device for use with a vehicle that

~~provide an improved safety device for use with a vehicle that~~ employs a positive release mechanism to release a source of pressurized fluid and inflate an air bag.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 11a is a side cross-sectional view of an embodiment of the present invention with a mechanical cutter actuated by air through a sensor-activated valve and with a brittle seal such as glass.

FIG. 11b is a side cross-sectional view of the device of FIG. 11a after the actuated mechanical cutter has cut and shattered the seal to inflate the bag (not drawn to scale).

FIG. 12 is a frontal view of taken along line 12-12 of FIG. 11b.

FIG. 13 is a cross-sectional view taken along line 13-13 in FIG. 11a.

FIG. 14a is a bottom view of the actuator plate used in the device of FIG. 11a shown in isolation for drawing clarity.

FIG. 14b is a cross-sectional view of the actuator plate of FIG. 14a taken along line 14b-14b of FIG 14a.

FIG. 14c is a cross-sectional view of the actuator plate of FIG. 14a taken along line 14c-14c of FIG. 14a.

BEST MODE FOR CARRYING OUT THE INVENTION

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device and method, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring to FIGS. 11a-14c, an embodiment of the present invention is illustrated as air bag unit 132. Unit 132 may be located in a multitude of positions within a vehicle and may be activated by any one of a number of types of collision sensing devices. Such collision sensing devices, for example, are electrical contact switches, and

can also be motion detectors such as inertial switches and accelerometers. Air bag unit 132 includes air bag 127 coupled to pressurized air canister 153 and separated by a mechanism which cuts membrane or seal 172. Air bag 127 may be of a variety of types of designs, sizes and shapes, and a preferred design includes a fabric bag having a rubberized lining. Although canister 153 may be a variety of shapes and sizes, in the illustrated embodiment it is cylindrical in shape and adapted to be mounted in steering column 100 as illustrated in phantom lines.

Seal 172 in the preferred embodiment comprises tempered glass which is sufficiently strong to withstand the pressure differential between high pressure chamber 107 in canister 153 and low pressure chamber 108, free of any movable support or lid. Seal 172 is preferrably held in place by compressive forces exerted by elastomeric damper mount 174 which in turn is compressed between an annular boss of seal compressor ring 170 and a lower seat of canister cover 152 (see FIG. 11a). In this way, seal 172, which in this embodiment is a brittle material such as glass or otherwise, is suspended in elastomeric material which dampens vibrations such as mechanical vibrations and sonic vibrations, thereby reducing the risk of accidental fatigue, cracking and failure of seal 172.

Canister cover 152 provides a cover for canister 153 to enclose pressure chamber 107. Cover 152 may be held in place by a variety of mechanical features such as a C-clamp structure (not shown), welding or other attachment. O-ring 118a is provided in the illustrated embodiment to maintain a pressure tight seal in chamber 107. Mounted on canister cover 152 is actuator plate 164, and mounted thereon is transfer plate 113, the three parts being held together in a variety of ways such as circumferentially disposed machine screws such as screws 105 (see FIG. 12) in screwholes 106 (see FIG. 14a).

Cutting tool 162 in this embodiment comprises a cylindrical body with a conical tip, it having been found that forming the conical tip from hardened steel (for example having a Rockwell hardness of 50-52 on the C-scale) provides

suitable cutting action to shatter seal 172 upon striking it. Cutting tool 162 reciprocates up and down with piston 158, but as illustrated in FIG. 11a, is biased upwardly by compression spring 160. Duct 130 and 130a, which communicate the upper surface of piston 158 in cylinder 159 with high pressure chamber 107, are shut by a valve, such as spool valve 197. Accordingly, in the configuration of FIG. 11a the pressure in duct 130 (typically ambient) is substantially in equilibrium with the pressure in low pressure chamber 108, and accordingly the piston and cutting tool 162 remain biased upwardly by spring 160. However, upon a signal, such as by sensing a collision, valve 197 is open, thereby communicating high pressure chamber 107 with the top surface of piston 158 through the duct. In the illustrated embodiment this valve is actuated by solenoid 183 moving solenoid plunger 183a radially inward to slide spool valve 197 against the radially outward bias of spring 185, thereby allowing pressurized fluid to flow through the central region of the spool valve into duct 130, as illustrated in FIG. 11b such as by the flow of arrow 130b. In this condition, the pressure in duct 130 and along the top surface of piston 158 exceeds the pressure in low pressure chamber 108 sufficiently to overcome the bias of spring 160 and rapidly moves piston 158 and cutting tool 162 downwardly until the cutting tool strikes membrane 172 to pierce or cut seal or membrane 172. Alternatively the cutting tool may be positioned to strike the seal on the high pressure side of the seal. The valve may be opened by other means such as fluid pressure from a manifold-sensor system. O-ring 118b provides a seal along duct 130a. O-ring 118c provides the seal between piston 158 and cylinder 159. Air bag ring 117 is securely mounted to the remainder of air bag unit 132 with air bag 127 squeezed in compression in between to hold the air bag in place.

As illustrated in FIG. 11b, upon such cutting or striking action, seal 172 is shattered into fragments, such as fragment 172a. Preferably, seal 172 is made of a brittle material, such as glass and preferably tempered glass, which upon sufficient force shatters into fragments. Other brittle materials are envisioned including ceramics, porcelain,

brittle alloys, mixtures or composites, brittle sintered members, brittle plastics or polymers, or other brittle material, the important feature being that upon being stricken by the cutting tool or otherwise acted upon, the brittle seal undergoes extremely rapid crack propagation and shatters into numerous discrete fragments to provide nearly instantaneous disintegration of the seal for extremely rapid liberation of the pressured fluid into the air bag. This provides the advantage of virtually instantaneous opening of the entire orifice previously occupied by the seal, giving extremely rapid, controllable and consistent air flow into the bag. The preferred brittleness is characterized by having the yield stress of the seal substantially equal to the tensile strength of the seal. It also is preferred to have tempered glass or other such amorphous material which has a tendency to exhibit multi-directional rapid crack propagation so as to shatter into numerous small fragments. In this way, seal 172 nearly instantaneously disintegrates, allowing tremendously fast liberation of compressed gas into the air bag. A brittle seal is contemplated in any of the other embodiments described herein.

As stated above, it is preferred that the thickness and shape of seal 172 is sufficient to not require support, such as by a movable gate or lid. Nevertheless, it is to be understood that optionally a support grid, filter or frame structure (not shown) may be provided (such as on the low pressure side of the seal) to provide support while being sufficiently skeletal or porous to allow the seal to shatter and the pressurized gas to be liberated. This option allows for thinner seals, thereby reducing the mass of fragments available to plug the filter and/or flow into the bag.

An additional feature of the present invention is the use of a filter downstream of the seal between the seal and the air bag. In the preferred embodiment, this is shown as a dual filter comprising a sintered brass wire filter 177 and a porous foam filter 179. It is to be understood that a variety of other filter structures and materials may be used as well. This filters out debris such as fragment 172a (see FIG. 11b) from the shattered seal. The filter further

provides the advantage of muffling or dampening sound, a common complaint after deployment of an air bag. Furthermore, the filter may further fragmentize larger fragments of the shattered seal so that any fragments of the seal entering air bag 127 are sufficiently small to not pose a meaningful risk of rupturing or penetrating through air bag 127. In the preferred embodiment, sintered brass wire filter 177 is doughnut-shaped and nested adjacent to STYROFOAM filter 179 in an annular channel of actuator plate 164 surrounding cylinder 159. Air flows from high pressure chamber 107 through the filters and through a plurality of axial vents 155 and/or radial vents 157 into air bag 127. Preferably these axial and radial vents are circumferentially disposed substantially around the entire mechanism to allow sufficient cross-sectional area for rapid liberation of pressurized fluid.

Preferably, seal 172 and its mounted opening should be sufficiently large in cross-sectional area to likewise allow rapid liberation of pressurized fluid without undue constriction. In the preferred embodiment, seal 172 is disc-shaped having a thickness of 0.375 inches (0.953 cm.) and a diameter of 1.8 inches (4.572 cm.). It is envisioned that canister 153 will be maintained with approximately 1,100 to 1,200 PSI (77.338 kg/sq. cm. to 84.368 kg/sq. cm.) pressure, although pressure may be higher or lower depending on design criteria including the size of the bag to be inflated, timing considerations, the volume of chamber 107 and airflow frictional considerations. Also, the porosity of the filters and the area of the filters, the seals and the vents may be enlarged, decreased or altered to vary the air flow speed according to design criteria. The pressure may be upwards of 2,000 or 3,000 PSI (140.614 kg/sq. cm. to 210.921 kg/sq. cm.) if necessary. In the preferred embodiment, canister 153 has an inside diameter of 4.625 inches (11.748 cm.) and a depth of about three inches (7.62 cm.). Other sizes and shapes may be used as well. Canister 153 may be initially pressurized by pressurized fluid from line 135. In the preferred embodiment, fill line 135 includes a shut-off valve and a pressure gauge (not shown) maintaining

pressurized chamber 107 as an independent closed chamber. The gauge provides assurance that the system is pressurized. Alternatively, chamber 107 may be communicated with outside pressure source. Similarly, although preferably duct 130 communicates with high pressure chamber 107, alternatively it may be coupled to an outside pressure source. Other means for shattering the seal or actuating cutting tool 162 may be utilized instead of a pressure actuated piston system as illustrated, such as a direct solenoid actuation, compression spring drive cutter, inertia actuation or other such system. Furthermore, in the context of a brittle membrane or seal 172, although a striking action from a cutting tool is preferred, it is possible to initiate crack propagation of the brittle material by an initial detonation, such as a blasting cap or the like, which is not sufficient to inflate the air bag but is sufficient to initiate shattering of seal 172 and such device is within the term cutter as set forth as the invention. Such device would be imbedded in or placed in proximity or in contact with seal 172. Other cutting, shattering techniques may be used including shock wave or sound wave initiated shattering.

FIG. 12 shows a frontal view of the device as viewed from inside of the air bag. Axial vents 155 are illustrated with radial vents 157 in alignment therewith. Plate 113 is secured in place with screws to actuator plate 164 and canister cover 152. Actuator plate 164 has a radial portion better illustrated in FIGS. 14a and 14c which includes a threaded solenoid hole 184 for mounting solenoid 183 therein. Solenoid is activated by current provided from a signal through wires 197a and 197b.

FIG. 13 shows a cross-sectional view looking at brittle seal 172 which, in the embodiment, is transparent tempered glass through which cutting tool 162 and filter 177 may be seen. Seal 172 is held to cover plate 152 by ring 170 and the elastomeric member 174 (not shown).

FIGS. 14a, 14b and 14c show actuator plate 164 in isolation due to its particular configuration in this embodiment, having radial vents 157 and axial vents 155 along with screw holes 106. The central-most aperture is the

aperture through which the cutting tool moves to strike the seal. Due to the presence of the radial objection defining solenoid hold 184, although the sintered brass seal is doughnut-shaped all the way around the structure, the foam seal 179 is C-shaped and nests down in the annular channel substantially coplanar with hole 184.

The method of operation of the present device is substantially set forth above and includes providing the structure described and shattering the brittle seal into fragments, thereby allowing fluid flow from the force of pressurized fluid 107 to inflate air bag 127. This method further includes filtering, such as by filters 177 and/or 179, of fragments out of the fluid flow.

It is desirable to have the overall air bag and sensor system independent from the other systems of the vehicle. This allows operation of the present invention regardless of the operability of other vehicle systems during a collision.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Cushioning apparatus to be mounted in a vehicle having collision sensing means to rapidly generate a signal in response to a collision, said cushioning apparatus being deployed upon collision to protect an occupant in the vehicle from injury and including a reservoir containing prior to collision a pressurized fluid and having an outlet, an inflatable cushion having an inlet and adapted to be inflated solely by said pressurized fluid, a frangible plate supported around the periphery thereof so as to leave the major central area of said frangible plate unobstructed, said frangible plate having an upstream side facing the outlet of the reservoir and a downstream side opposite said upstream side, the frangible plate sealing the outlet of said reservoir and interposed between the outlet of the reservoir and the inlet of the inflatable cushion, and means to permit the pressurized fluid within the reservoir to rupture the frangible plate in response to a signal from said collision sensing means and inflate the cushion, wherein:

the frangible plate rapidly shatters into discrete fragments when struck,

a striking member is provided adjacent the downstream side of the frangible plate and has a longitudinal axis, a first end to strike the frangible plate and rapidly shatter the frangible plate, a second end opposite said first end, and a transverse cross section substantially smaller than the major central area of the frangible plate,

second means are provided to mount the striking member for movement along its longitudinal axis toward the downstream side of the frangible plate,

third means are provided to rapidly apply a force to the second end of the striking member in response to said signal generated by the collision sensing means to drive the striking member along its longitudinal axis toward the downstream side of the frangible plate so that the first end of the striking member shatters the frangible plate,

a passage generally annularly disposed about the striking member is provided and has area adequate to permit the rapid flow therethrough of pressurized fluid from the reservoir into the inflatable cushion, and

filter means are interposed between the frangible plate and the inlet of the inflatable cushion.

2. Cushioning apparatus as claimed in claim 1, wherein:

the filter means are mounted in the passage and are generally annularly disposed about the striking member.

3. Cushioning apparatus as claimed in claim 1 or claim 2, wherein:

the first end of the striking member shatters the entire central area of the frangible plate inwardly of its peripheral support.

4. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

the third means applies fluid pressure to the second end of the striking member.

5. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

the transverse cross-sectional area of the second end of the striking member is greater than the transverse cross-sectional area of the first end of the striking member.

6. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

the pressurized fluid in the reservoir is air or carbon dioxide.

7. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

valve means are provided having an inlet communicating with said source of pressurized fluid and an outlet communicating with the second end of the striking member, and

the valve means rapidly opens upon receiving said signal from the collision sensing means to permit the rapid application of pressure from said source of pressurized fluid to the second end of the striking member

to advance the first end of the striking member to shatter the frangible plate and inflate the cushion.

8. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

fluid conduit means are provided which communicate between the reservoir and the second end of the striking member, and

a valve means is operatively interposed in the fluid conduit means and rapidly opens upon receiving said signal from the collision sensing means to permit the rapid application of pressure from the reservoir to the second end of the striking member to advance the first end of the striking member to shatter the frangible plate and inflate the cushion.

9. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

the frangible plate is glass, tempered glass, ceramic, brittle alloys, brittle sintered material or brittle polymeric material.

10. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

the first end of the striking member strikes the center of the downstream side of the frangible plate.

11. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

the first end of the striking member is tapered substantially to a point.

12. Cushioning apparatus as claimed in any one of the preceding claims, wherein:

the inlet of the inflatable cushion is substantially aligned with the outlet of the reservoir.

13. Cushioning apparatus substantially as herein described with reference to the accompanying drawings.

DATED : 22 November 1994
PHILLIPS ORMONDE & FITZPATRICK
Attorneys for:
IDEATECH, INC.

David B Fitzpatrick

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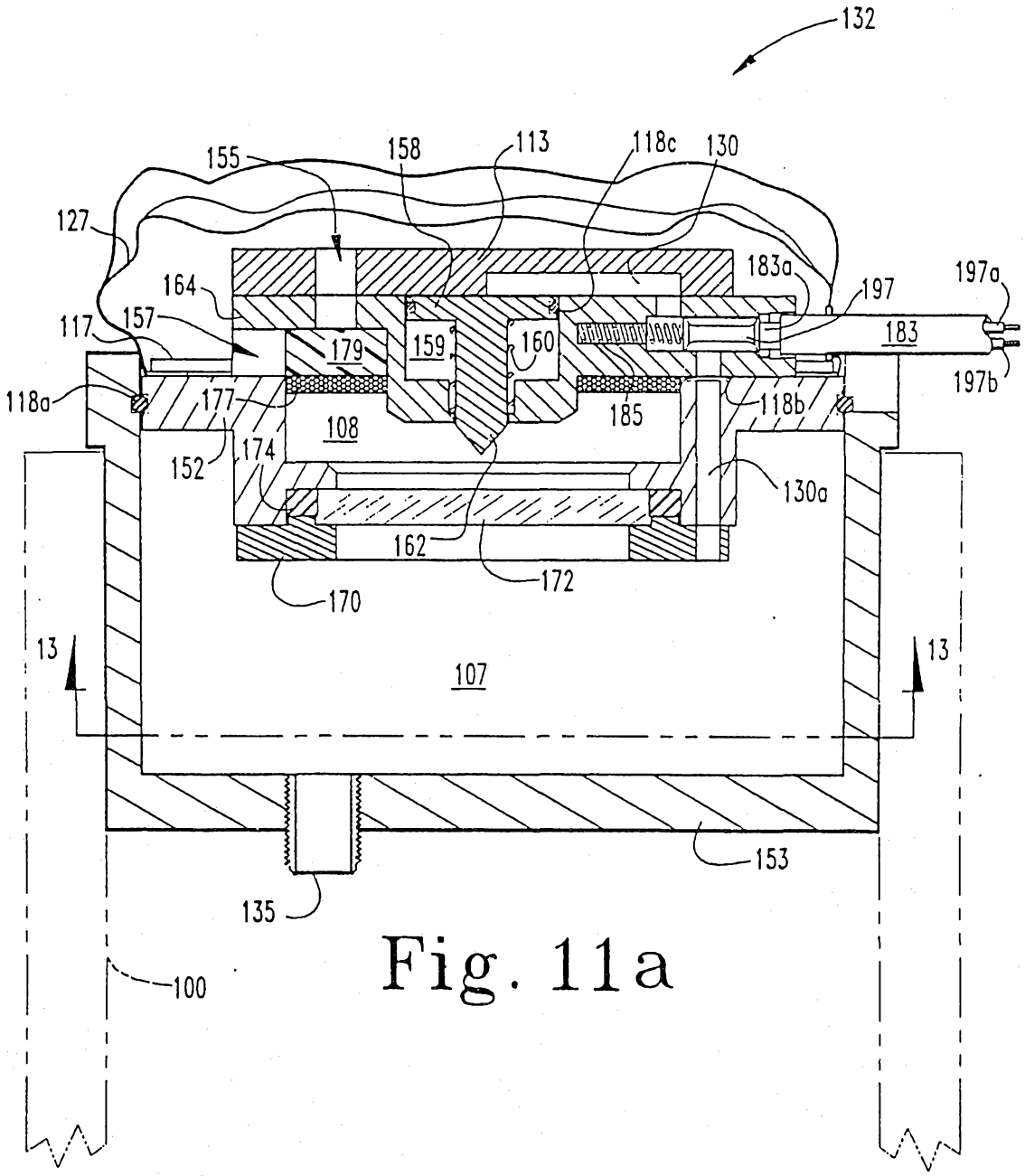
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Fig. 11a

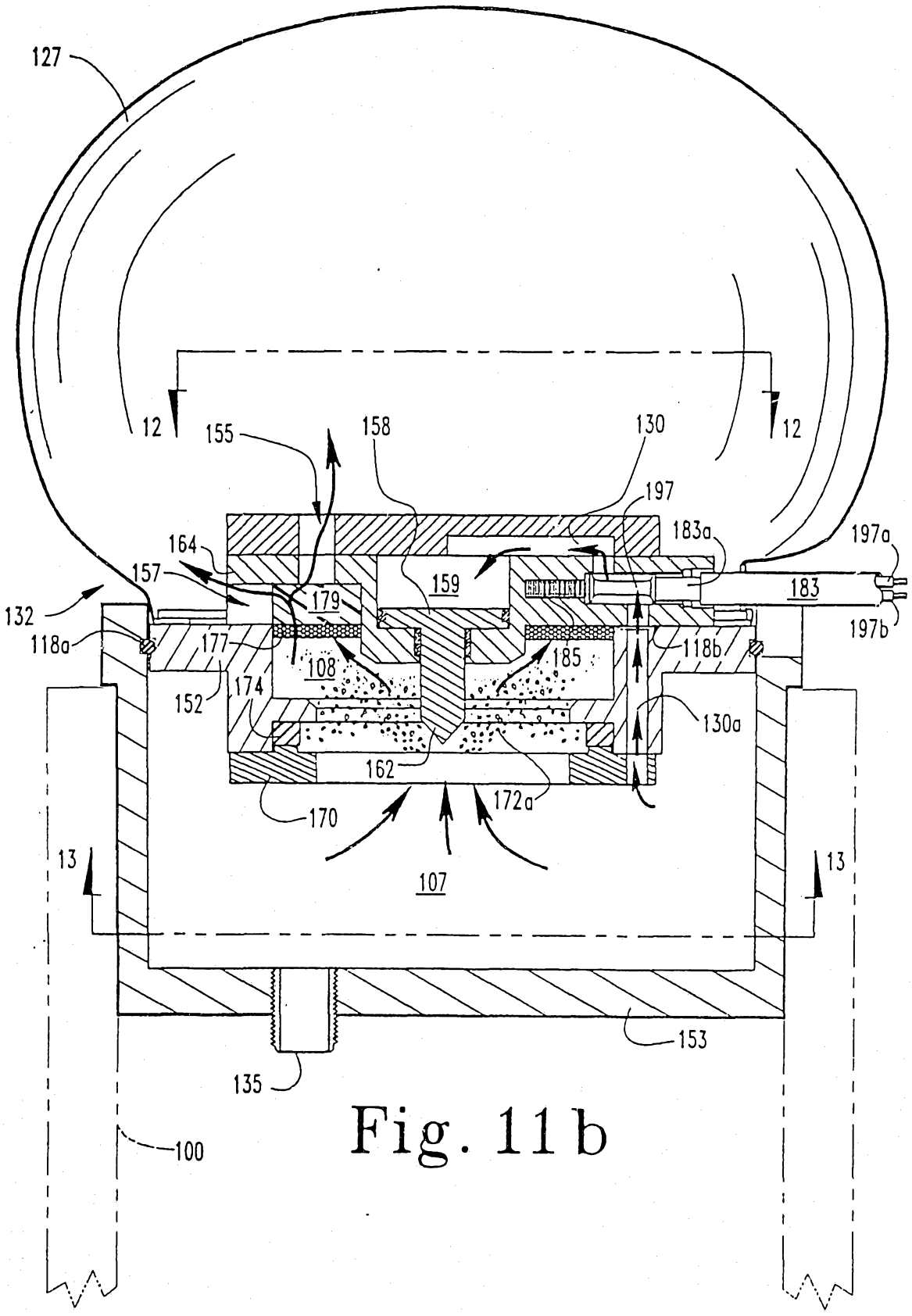
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Fig. 11b

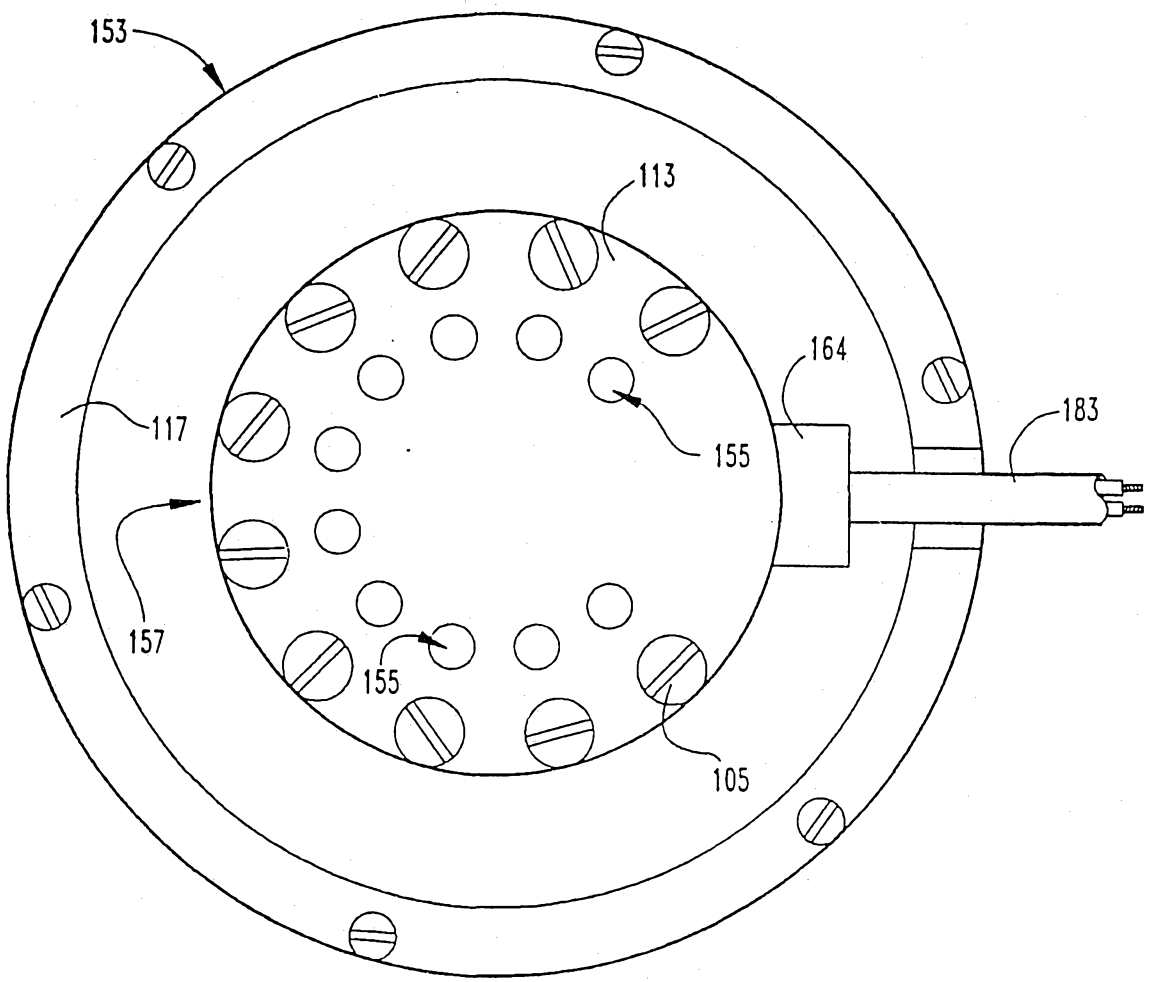

Fig. 12

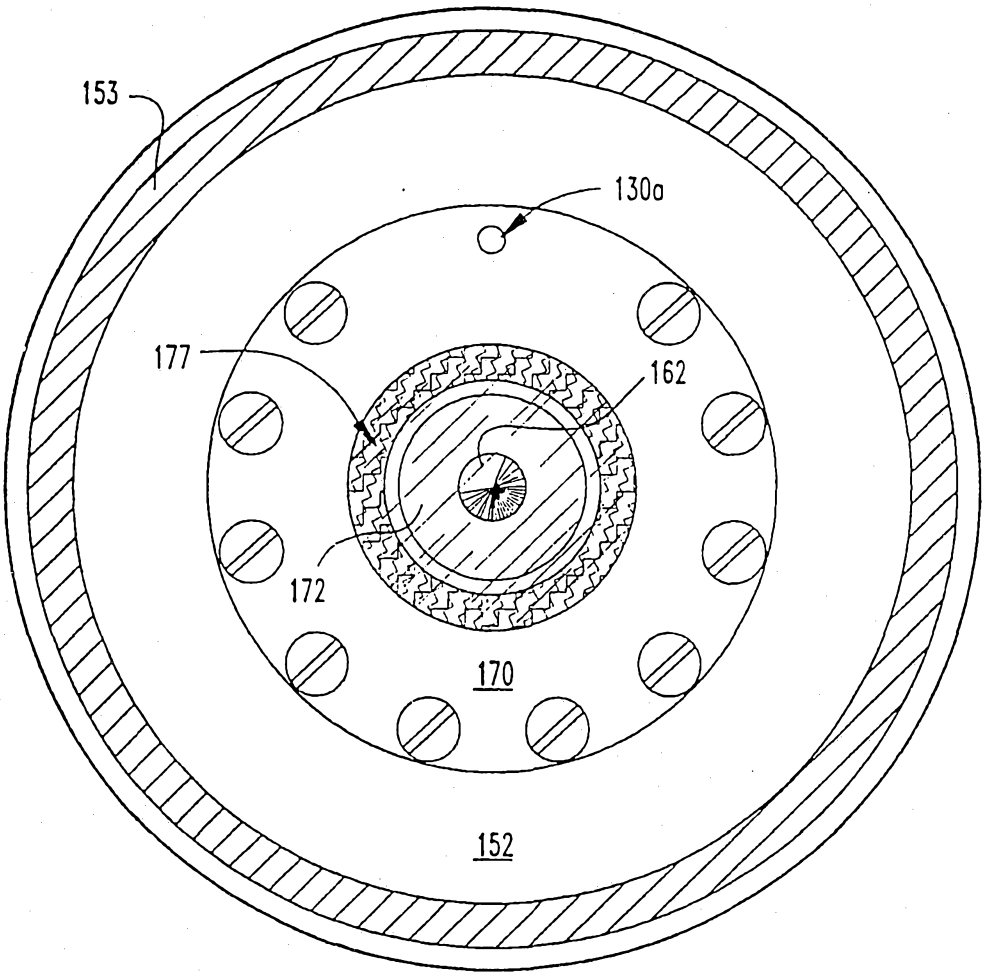

Fig. 13

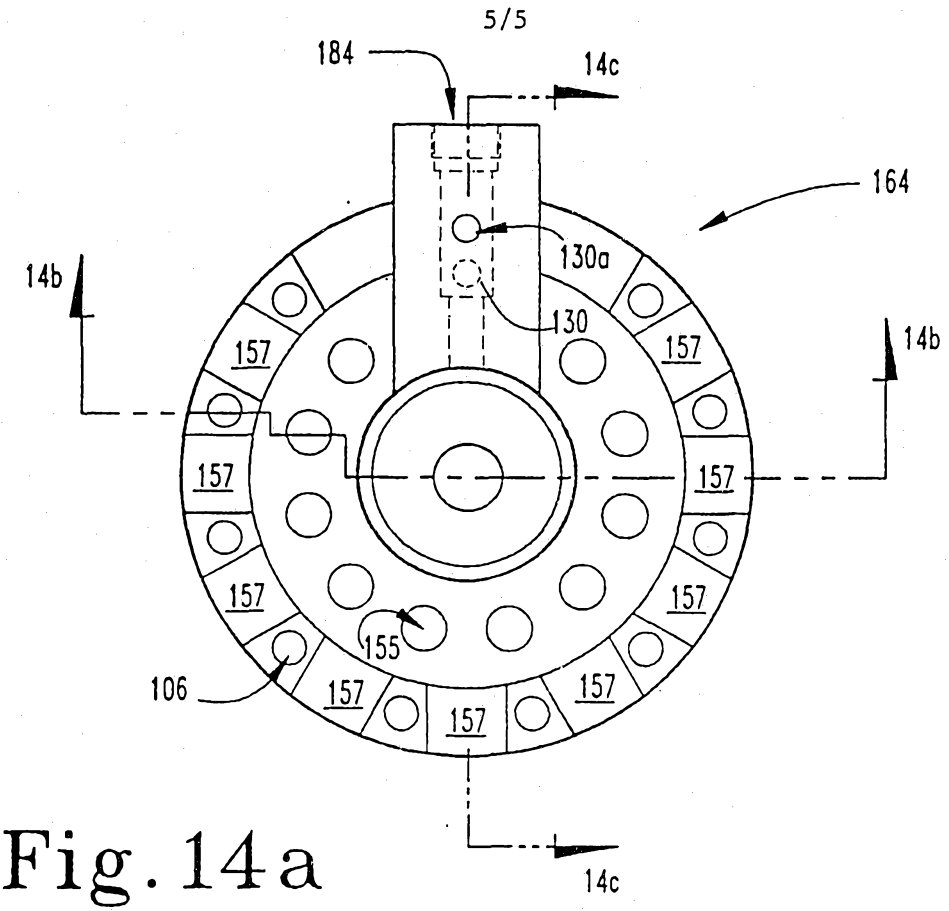

Fig. 14a

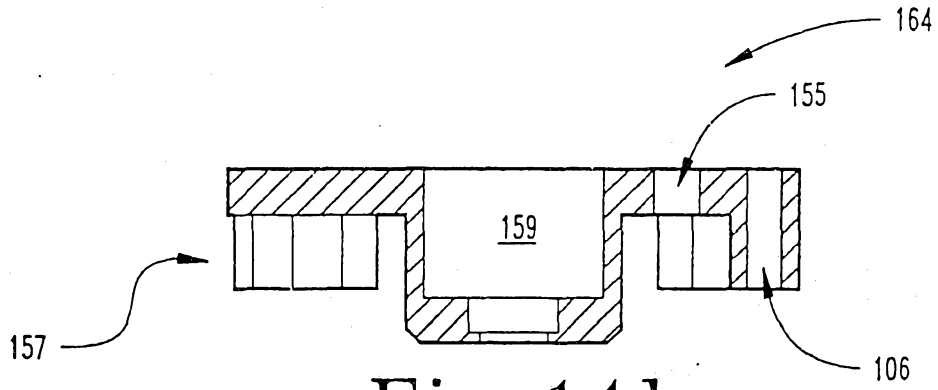

Fig. 14b

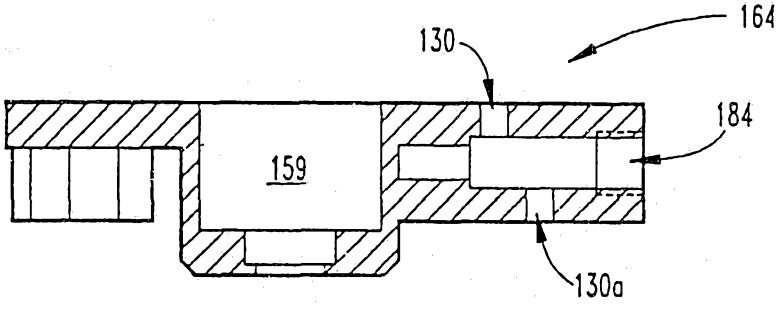

Fig. 14c

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/06021

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :B60R 21/26
US CL :280/737; 222/5

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. : 280/728,734,736,741,742; 226/267; 137/68.2

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,913,604 (HANSON ET AL.) 21 October 1975, See entire document.	1,3-7,9-12
Y	UK, A, 1,378,079 (HAMILTON ET AL.) 18 December 1974, See page 2, lines 89-93.	1,3-7,9-12
Y	US, A, 3,731,843 (ANDERSON, JR.) 08 May 1973, See entire document.	7
Y	US, A, 3,834,729 (OKA ET AL.) 10 September 1974, See entire document.	9
Y,P	US, A, 5,076,607 (WOODS ET AL.) 31 December 1991, See entire document.	1,10

[X] 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
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"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
"E"	earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search	Date of mailing of the international search report
07 OCTOBER 1992	20 NOV 1992
Name and mailing address of the ISA/ Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer KARIN TYSON
Facsimile No. NOT APPLICABLE	Telephone No. (703) 308-1113

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/06021

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,731,948 (RISKO) 08 May 1973, See entire document.	9
Y	US, A, 3,744,816 (YAMAGUCHI ET AL.) 10 July 1973, See entire document.	10
Y	US, A, 3,966,226 (ROTH) 29 June 1976, See entire document.	12