Title: IMPROVEMENTS IN OR RELATING TO A PRE-TENSIONER

Abstract: A seat belt pre-tensioner (1) is disclosed, which comprises a cylindrical bore (3) having a moveable piston (11) received therein. The piston (11) is connected to an elongate element such as a wire or cable (16), which extends through an outlet passage (8) for connection to part of a safety-belt arrangement. A substantially frusto-conical seal (17) is provided within a corresponding frusto-conical extension (6) of the bore (3). The frusto-conical extension (6) narrows towards the outlet passage (8), and the seal (17) is moveable within the frusto-conical extension (6) of the bore (3) towards the outlet passage (8) in response to the application of pressure to the seal (17) when gas is introduced into the bore (3) of the pre-tensioner.
“IMPROVEMENTS IN OR RELATING TO A PRE-TENSIONER”

THE PRESENT INVENTION relates to a pre-tensioner, and more particularly relates to a pre-tensioner adapted to apply tension to part of a safety-belt provided within a motor vehicle.

It has been proposed previously to provide a pre-tensioner to apply tension to a safety-belt provided within a motor vehicle. Such a pre-tensioner is actuated in response to a signal from a crash sensor indicating that an accident is occurring. The function of the pre-tensioner is to apply tension to part of the safety-belt arrangement so that any slack initially present in the safety-belt before an accident is taken up very quickly, in the even of an accident, so that the safety-belt is brought to a condition in which it is relatively tightly engaging the occupant of the seat. Thus, as soon as the occupant of the seat begins to move forwardly, relative to the seat, that forward movement is restrained by the safety-belt. Thus the risk of the seat occupant impacting with a fixed part of the vehicle, such as a steering wheel or dashboard, is minimised.

A typical prior proposed pre-tensioner comprises a piston-and-cylinder arrangement, the piston being connected, for example by a wire or cable, to part of a safety-belt. A gas generator is provided to inject gas into the cylinder, when an accident arises, to move the piston so that tension is applied to the
safety-belt. The wire or cable connecting the piston to the safety-belt typically passes through an end wall of the cylinder.

It has been proposed, in order to avoid gas leakage from the cylinder, to provide a seal which seals against the wire or cable where it passes through the end wall of the cylinder. EP 0 654 50 A2 discloses a prior proposed pre-tensioner arrangement in which a frusto conical seal is provided around a cable in the region where the cable exits the cylinder. The frusto-conical seal is seated within a similarly shaped frusto-conical recess provided in the housing of the pre-tensioner, such that the narrow end of the seal is directed towards the piston. The seal is inserted into the recess and is held in place by a cover or through a setting operation. The characteristics of the sealing effect provided by the seal of this arrangement are predetermined when the arrangement is assembled.

The present invention seeks to provide an improved pre-tensioner.

According to the present invention, there is provided a pre-tensioner for a safety-belt arrangement, the pre-tensioner comprising a cylinder defining a bore and an arrangement to supply gas to the bore in the event that an accident should occur; the cylinder containing a piston moveable within the bore in response to the supply of gas to the bore, the piston being connected to an elongate element which extends from the cylinder through an outlet passage for connection to part of a safety-belt arrangement, there being a seal associated with the elongate element, the seal comprising a substantially frusto-conical element of resilient or yieldable material and defining a passage through which the elongate element passes; the frusto-conical extension being received within a corresponding frusto-conical extension of the bore of the cylinder, the frusto-conical extension of the bore narrowing towards the outlet passage, the seal
being movable within the frusto-conical extension of the bore towards the outlet passage in response to the application of pressure to the seal when gas is introduced into the bore of the cylinder.

Preferably, between the frusto-conical extension of the bore and the outlet passage, a cylindrical chamber is provided, the cylindrical chamber having a greater diameter than that of the outer passage.

Advantageously, the passage through the seal has, at the relatively narrow end of the frusto-conical seal, a bell mouth.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, an embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a diagrammatic sectional view showing part of a pre-tensioner in accordance with the invention, before deployment;

FIGURE 2 is an enlarged view of part of the embodiment of Figure 1, during deployment of the pre-tensioner;

FIGURE 3 is a view corresponding to Figure 2 provided for purposes of explanation;

FIGURE 4 is a view corresponding to Figure 2 showing a subsequent stage in the deployment of the pre-tensioner, and

FIGURE 5 is a sectional view of a modified seal.
Referring initially to Figure 1 of the accompanying drawings, a pre-
tensioner 1 comprises a cylinder 2 defining a cylindrical bore 3. In the region
of one end of the cylinder 2, the bore 3 communicates, by a means of a laterally
extending passage 4, with a chamber 5 adapted to receive a gas generator. The
gas generator is arranged to be actuated upon receipt of a signal from a crash
sensor.

The end of the bore 3 adjacent the chamber 5 is formed into a
converging frusto-conical extension 6, where the diameter of the bore 3 reduces
substantially evenly over the length of the extension 6. The frusto-conical
extension 6 of the bore 3 terminates with a relatively short cylindrical chamber
7 of uniform cross-section. The cylindrical chamber 7 of uniform cross-section
terminates with an outlet passage 8 of circular cross-section. However, the
diameter of the cylindrical chamber 7 is slightly greater than the diameter of the
outlet passage 8 such that a small end wall 9 is defined at the left-most end of
the cylindrical chamber 7.

Rotatably mounted on the end of the cylinder 2 adjacent the outlet
passage 8, is a pulley-wheel 10. However, in other embodiments, it is
envisaged that the rotatable pulley-wheel 10 could be replaced with a non-
rotatable guide.

Within the bore 3, there is provided a piston 11 of generally
conventional design. The piston 11 defines a radially outwardly extending
flange 12 provided with a peripheral groove which contains a resilient sealing
material 13 to provide a gas-tight sliding fit between the piston 11 and the wall
of the bore 3. The piston includes a tapering body portion 14, the narrow end
of which is connected to the flange 12. Surrounding the tapering body portion
14 of the piston, there is provided a plurality of balls 15, which (as will become apparent hereinafter) act to prevent subsequent movement of the piston 11 to the left as illustrated, after actuation of the pre-tensioner.

An elongate element, preferably in the form of a wire or cable 16 extends from the piston 12 and passes axially along the bore 3, through the frusto-conical extension 6 of the bore 3, through the cylindrical chamber 7 and out of the bore 3 via the outlet port 8. The wire or cable 16 then passes around the pulley 10 to be connected to part of a safety-belt arrangement.

Seated within the frusto-conical extension 6 of the bore is a correspondingly shaped frusto-conical seal 17, the seal 17 being formed of a resilient or yieldable material. The seal 17 has a frusto-conical exterior surface which matingly engages with the interior wall of the frusto-conical extension 6 of the bore 3. The seal 17 is provided with an axial passage 18 through which the wire or cable 16 passes. The axial passage 18 through the seal 17 has an initial diameter (when the seal 17 is in a relaxed, uncompressed condition) which is substantially equal to, or only slightly smaller than the diameter of the wire or cable 16, so as to ensure a good seal thereagainst.

At its end remote from the piston 11 and located at the narrowest end of the seal 17, the passage 18 through the seal 17 may be slightly divergent so as to have a chamfered “bell mouth” 19 (illustrated most clearly in Figure 2).

In the event that an accident should arise, a signal from a crash sensor is passed to the gas generator within the chamber 5 to actuate the gas generator and cause gas to flow through the passage 4 into the region of the bore 3 between the piston 11 and the seal 17, as shown in Figure 2. The piston 11 is thus urged along the bore 3 towards the right by the very high pressure of the
gas, as shown in Figure 1, drawing the wire or cable 16 into the cylinder 2 and thus applying tension to part of the safety-belt arrangement. When the piston 11 has stopped moving in this way towards the right as illustrated, should a force be applied to the wire or cable 16, moving the piston 11 slightly back to the left, the balls 15 will ride up the tapering body portion 14 of the piston 11 and become jammed between the tapering body portion 14 of the piston and the side-wall of the cylinder 2, thus preventing subsequent movement of the piston 11 towards the left.

As gas is injected into the part of the bore 3 of the cylinder 2 between the piston 11 and the seal 17, the pressure of gas applied to the seal 17 will rise. Thus a situation will exist, as shown in Figure 3, where the wire or cable 16 may be moving towards the right as shown, whilst the gas pressure P is applied in an opposite sense to the widest end face of the frusto-conical seal 17. The seal 16 is thus urged towards the left, as shown in Figure 3 under the action of gas pressure.

Due to the frusto-conical configuration of the seal 17 and the frusto-conical extension 6 of the bore 3 within which it is seated, the seal 17 becomes radially compressed as it is urged towards the narrow end of the frusto-conical extension 6 of the bore 3. The effect of this radial compression of the seal 17 is that the diameter of the passage 18 through the seal 17 becomes reduced so that the seal 17 firmly grips the wire or cable 16, thus minimising the risk of gas leakage from the cylinder 2.

As the pressure continues to rise, the seal 17 is urged further into the frusto-conical extension 6 of the bore 3, thereby compressing the seal 17 further and tightening its sealing engagement against the wire or cable 16. Eventually, the narrowest end of the seal 17 is driven into the cylindrical chamber 7
adjacent the outlet passage 8, and abuts the end wall 9 of the cylindrical chamber 7 as shown in Figure 4. This serves as a stop against further movement of the narrowest end of the seal 17 along the conical extension of the bore 3, and minimises the risk of part of the seal 17 being driven into the outlet passage 8. If part of the seal 17 was to be driven into the outlet passage 8, there would be a risk that the material of the seal 17 would become so firmly engaged with the wire or cable 16 that, as the wire or cable 16 was moving towards the right with the piston 11, parts of the seal 17 would be entrained with the wire or cable 16, and the seal 17 would be torn apart.

The chamfered “bell mouth” 19 provided at the end of the passage 18 extending through the seal 17, ensures that even when the seal 17 is highly radially compressed in the manner explained above, the end face 21 of the seal 17 is always spaced slightly away from the wire or cable 16. This spacing of the narrowest end face 21 of the seal 17 from the wire or cable 16 minimises any tendency for the end face 21 to be drawn into the passage 18 through the seal 17 by movement of the wire or cable 16 to the right as illustrated, hence distorting the seal 17 or causing it to be torn apart.

In order to further minimise the risk of the seal 17 entering the outlet passage 8, the narrowest end of the seal 17 that is to be driven into the cylindrical chamber 7 may be provided with a reinforcing element in the form of a ring of relatively hard material 20, dimensioned to abut the end wall 9 of the cylindrical chamber 7, as shown in Figure 5.

In the present specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

CLAIMS:
1. A pre-tensioner for a safety-belt arrangement, the pre-tensioner comprising a cylinder defining a bore and an arrangement to supply gas to the bore in the event that an accident should occur; the cylinder containing a piston moveable within the bore in response to the supply of gas to the bore, the piston being connected to an elongate element which extends from the cylinder through an outlet passage for connection to part of a safety-belt arrangement, there being a seal associated with the elongate element, the seal comprising a substantially frusto-conical element of resilient or yieldable material and defining passage through which the elongate element passes; the frusto-conical element being received within a corresponding frusto-conical extension of the bore of the cylinder, the frusto-conical extension of the bore narrowing towards the outlet passage, the seal being movable within the frusto-conical extension of the bore towards the outlet passage in response to the application of pressure to the seal when gas is introduced into the bore of the cylinder.

2. A pre-tensioner according to Claim 1 wherein, between the frusto-conical extension of the bore and the outlet passage, a cylindrical chamber is provided, the cylindrical chamber having a greater diameter than that of the outlet passage.

3. A pre-tensioner according to Claim 1 or Claim 2 wherein the passage through the seal has, at the relatively narrow end of the frusto conical seal, a bell mouth.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60R 22/195
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)

IPC7: B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>GB 1407954 A (NISSAN MOTOR COMPANY), 1 October 1975 (01.10.75), column 1, line 43 - line 60, figure 2</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>EP 0625450 A2 (ALLIED SIGNAL LIMITED), 23 November 1994 (23.11.94)</td>
<td>1-3</td>
</tr>
<tr>
<td>A</td>
<td>EP 0808752 A1 (TRW OCCUPANT RESTRAINT SYSTEMS GMBH), 26 November 1997 (26.11.97)</td>
<td>1-3</td>
</tr>
<tr>
<td>A</td>
<td>WO 34817 98 (BREED AUTOMOTIVE TECHNOLOGY, INC.), 13 August 1998 (13.08.98)</td>
<td>1-3</td>
</tr>
</tbody>
</table>

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

Date of the actual completion of the international search:
29 August 2003

Date of mailing of the international search report:
02-09-2003

Name and mailing address of the ISA/Swedish Patent Office:
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer:
Hans Nordström / JA A
Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB 1407954 A</td>
<td>01/10/75</td>
<td>DE 2409159 A</td>
<td>12/09/74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2218909 A,B</td>
<td>20/09/74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 4008909 A</td>
<td>22/02/77</td>
</tr>
<tr>
<td>EP 0625450 A2</td>
<td>23/11/94</td>
<td>GB 9310445 D</td>
<td>00/00/00</td>
</tr>
<tr>
<td>EP 0808752 A1</td>
<td>26/11/97</td>
<td>BR 9704849 A</td>
<td>06/10/98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1170677 A</td>
<td>21/01/98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 29609054 U</td>
<td>19/09/96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 59700267 D</td>
<td>00/00/00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 59701915 D</td>
<td>00/00/00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 59704078 D</td>
<td>00/00/00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0889812 A,B</td>
<td>13/01/99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0898527 A,B</td>
<td>03/03/99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2111509 T</td>
<td>16/03/98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 10044935 A</td>
<td>17/02/98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5897140 A</td>
<td>27/04/99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6094913 A</td>
<td>01/08/00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6250720 B</td>
<td>26/06/01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 9739923 A</td>
<td>30/10/97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 9744217 A</td>
<td>27/11/97</td>
</tr>
<tr>
<td>WO 34817 98</td>
<td>13/08/98</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>