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(54) Title: SAFETY ARRANGEMENT

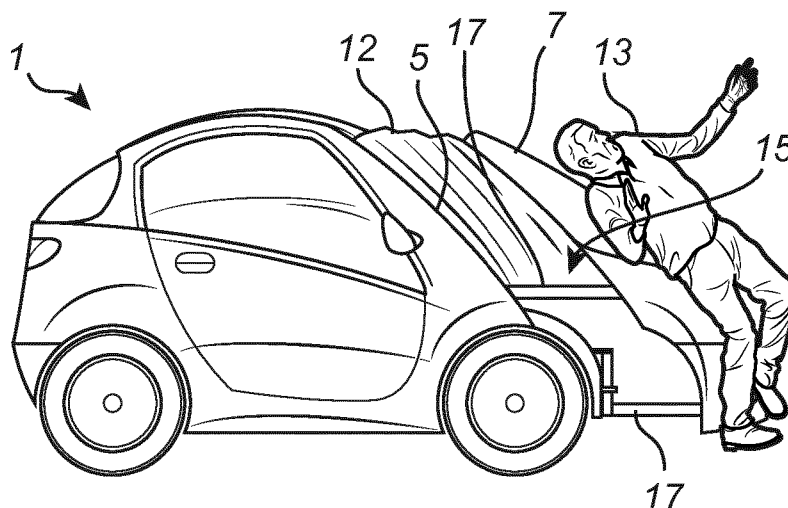


Fig. 1c

(57) Abstract: The present invention relates to a safety arrangement configured to be mounted in a vehicle (1) having a front-end member (7) and a vehicle structure member (5) to which the front-end member (7) is releasably connected. The safety arrangement comprises an energy absorbing device (15), a release device arranged to, upon heavy braking, release said front-end member (7) to allow the front-end member (7) to be moved forwardly in a vehicle forward direction by inertia forces during the heavy braking, and a locking device capable of locking the front-end member in a forward position, wherein a pedestrian or a cyclist (13) that is impacted by the front-end member (7) deforms the energy absorbing device (15).



SAFETY ARRANGEMENT

Technical Field of the Invention

The present invention relates to a safety arrangement configured to be mounted in a vehicle having a front-end member and a vehicle structure member to which the front-end member is releasably connected.

Background Art

In order to try to minimize injury to a pedestrian hit by a vehicle, it has been proposed previously to raise a part of the hood before the pedestrian lands on the hood. Such a hood hood-lifting arrangement can work effectively when installed in a medium size vehicle which has a standard length hood.

However, it is less effective when used in a vehicle which has a shorter than average hood, such as a small car or a light truck.

Summary of the Invention

It is an object of the present invention to provide improved protection of pedestrians hit by a vehicle.

These and other objects that will be apparent from the following summary and description are achieved by a safety arrangement according to the appended claims.

According to an aspect of the present disclosure there is provided a safety arrangement configured to be mounted in a vehicle having a front-end member and a vehicle structure member to which the front-end member is releasably connected, wherein the safety arrangement comprises an energy absorbing device arranged between said front-end member and said vehicle structure member as seen in a vehicle forward direction, a release device arranged to, upon heavy braking, release said front-end member to allow the front-end member to be moved forwardly in a vehicle forward direction by inertia forces during the heavy braking, and a locking device capable of locking the front-end member in a forward position, wherein a pedestrian or a

cyclist that is impacted by the front-end member deforms the energy absorbing device.

The front-end member, e.g. a bumper, windscreen or bumper windscreen combination, is thus, when the vehicle deceleration exceeds a
5 predetermined level in a sudden braking event, released from the vehicle structure member to which it is normally secured.

Due to its mass the front-end member has a certain inertia and will, once released, move in response to the vehicle deceleration during the heavy braking. The forward movement of the front-end member relative to the
10 vehicle structure member is thus energized by vehicle deceleration. This has the advantage that no external force is needed to move the front-end member forwardly to the forward position during heavy braking. There is thus no need for a driving means driving the front-end member to the forward position.

By moving the front-end member forwardly relative to the vehicle
15 structure member the safety arrangement is able to increase the roof edge wrap around distance of a vehicle having a shorter than average hood significantly. Furthermore, the safety arrangement is able to absorb energy during impact with a pedestrian. As the energy absorbing device deforms, the energy absorbing device absorbs energy from the pedestrian, decreasing the
20 relative speed of the pedestrian down gradually and thus minimizing injury to the pedestrian. Furthermore, the front-end member, or a member connected thereto, may act as a shield which may shield a pedestrian from part of the windscreen and from rigid parts, such as the cowl or roof, of the vehicle.

Hence, the safety arrangement minimises injury to a person hit by a
25 vehicle equipped with the safety arrangement. An efficient safety arrangement for protection of pedestrians hit by a vehicle is thus achieved. Especially, an improved safety arrangement for protection of pedestrians hit by a small vehicle, such as a small car, is achieved.

When released the front-end member thus moves forwardly by inertia
30 force, which enables a very cost-efficient solution. Furthermore, a robust and reliable solution may be achieved.

According to one embodiment said energy absorbing device is extendible. This has the advantage that an additional deformation distance may be created.

According to one embodiment the energy absorbing device comprises
5 at least one telescopic structure.

According to one embodiment the energy absorbing device comprises a self-locking telescopic device.

According to one embodiment said at least one telescopic structure comprises an outer tube and an inner tube telescoped into the outer tube.

10 According to one embodiment the front-end member is arranged to, upon activation of the safety arrangement, move linearly in the vehicle forward direction.

According to one embodiment the energy absorbing device comprises four telescopic structures, which provides for a very robust solution.

15 Furthermore, with four telescopic structures the energy absorbing during an impact with a pedestrian may be distributed which may further reduce the risk of injury to the impacted pedestrian.

According to one embodiment the front-end member is pivotally connected to the vehicle structure member. This embodiment has the
20 advantage that a cost-efficient solution comprising only two telescopic structures may be achieved.

According to one embodiment said release device is active and comprises an actuator arranged to operate an engaging element of the release device.

25 The active release device may be arranged to move an engaging element in order to release the front-end member. Release of the front-end member may thus be carried out in a very controllable and reliable manner. When the the active release device is activated the front-end member is free to move relative to the vehicle structure member, which enables an extendible
30 energy absorbing element to be extended and prepared for maximum energy absorbing when a pedestrian is hit by the vehicle.

According to one embodiment the release device comprises an actuator in the form of a pyrotechnical actuator or an electrical actuator. The use of such an actuator provides for a very controllable and reliable solution.

According to one embodiment said active release device comprises a
5 pyrotechnic actuator, which provides for very fast actuation and thus enables very fast release of the front-end member.

According to one embodiment said pyrotechnic actuator is arranged to operate an engaging element of the active release device.

According to one embodiment the release device comprises an electric
10 actuator in the form of a servo motor provided with a linearly displaceable rod.

According to one embodiment the release device comprises a pyrotechnic actuator in the form of a linear pyrotechnic piston actuator.

According to one embodiment said active release device comprises an electric, pneumatic or hydraulic actuator, which provides for a robust and
15 reliable release device that may be reset, automatically or manually, in an easy manner.

According to one embodiment the active release device is resettable, which enables the release device to be reset after activation. The active release device may thus be activated repeatedly. The active release device
20 may be reset manually or automatically. Hence, a reversible safety arrangement may be achieved.

According to one embodiment the release device comprises a breakable element, such as a breakable pin, which provides for a very cost-efficient solution.

25 The breakable element may be configured to break when subjected to a load that corresponds to a predetermined deceleration level of the vehicle.

According to one embodiment the predetermined deceleration level, at which the breakable element is configured to break, is 1,5 and more preferably 2g.

30 Hence, according to one embodiment the breakable element is thus configured to break when the vehicle deceleration exceeds 1,5g during a heavy braking event.

According to one embodiment the safety arrangement comprises a pre-crash sensor system capable of sensing a pedestrian in front of the vehicle, i.e. that is capable of predicting an impact with a pedestrian in front of the vehicle.

5 These and other aspects of the invention will be apparent from and elucidated with reference to the claims and the embodiments described hereinafter.

Brief Description of the Drawings

10 The invention will hereafter be described in more detail and with reference to the appended schematic drawings.

Fig. 1a is a side view of a vehicle provided with a safety arrangement according to an embodiment of the present disclosure.

15 Fig. 1b is a side view and illustrates the vehicle in Fig. 1a in a sudden braking event.

Fig. 1c is a side view and illustrates the vehicle in Fig. 1a in a collision with a pedestrian.

Fig. 2a-b illustrates a release device of the safety arrangement illustrated in Figs. 1a-c.

20 Fig. 3a-c illustrates a release device of a safety arrangement according to a second embodiment of the present disclosure.

Fig. 4a-c illustrates a release device of a safety arrangement according to a third embodiment of the present disclosure.

25 Fig. 5a is a side view of a vehicle provided with a safety arrangement according to a fourth embodiment of the present disclosure.

Fig. 5b is a side view and illustrates the vehicle in Fig. 5a in a sudden braking event.

Fig. 5c is a side view and illustrates the vehicle in Fig. 5a in a collision with a pedestrian.

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Detailed Description of Preferred Embodiments of the Invention

Fig. 1a shows a motor vehicle 1 provided with a safety arrangement 3 according to an embodiment of the present disclosure. The vehicle 1 comprises a vehicle structure member 5 and a front-end member 7. The front-end member 7 comprises a windscreen 9, a bumper 11 and a roof extender

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12 and is connected to the vehicle structure member 5. A pedestrian 13 is standing in front of the vehicle 1 as seen in a vehicle forward direction.

The front-end member 7 is releasably connected to the vehicle structure member 5. To this end the safety arrangement 3 comprises a
5 release device 6, which is illustrated in Figs. 2a-b. Upon activation of the safety arrangement 3 the front-end structure 7 is released to allow movement of the front-end member 7 relative to the vehicle structure member 5. Under normal conditions the front-end member 7 is secured to the front-end member 7 by a breakable engaging element 23, illustrated in Fig. 2a.

10 Upon heavy braking of the vehicle 1, e.g. when a pedestrian 13 in front of the vehicle 1 has been observed or detected, the safety arrangement 3 is activated, which allows the front-end member 7 to move, under the action of inertia forces during the vehicle deceleration following the heavy braking, forwardly relative to the vehicle structure member 5, as illustrated by arrow A
15 in Fig. 1b.

When the safety arrangement 3 is activated the front-end member 7 is thus moved forwardly in the vehicle forward direction to a forward position, illustrated in Fig. 1b, by inertia forces. The safety arrangement is activated if a predetermined vehicle deceleration, such as, e.g., 1g, is exceeded. Typically,
20 such a vehicle deceleration is reached during heavy braking when a pedestrian has been observed or detected in front of the vehicle 1. Hence, the safety arrangement 3 is not activated during a normal braking event, in which a vehicle deceleration of about 0,4g is typically reached.

In this embodiment the front-end member 7 is arranged to, when the
25 safety arrangement 3 is activated, move linearly to the forward position. The front-end member 7 is thus, when released, linearly displaceably relative to the vehicle structure member 5. To this end the safety arrangement 3 comprises four telescopic structures 17, two of which are schematically illustrated in Fig. 1b.

30 Now referring to Fig. 1b the safety arrangement 3 comprises an energy absorbing device 15 that is arranged between the vehicle structure member 5 and the front-end member 7. The energy absorbing device 15 comprises the four telescopic structures 17. Each telescopic structure 17 is at one end 17a

connected to the vehicle structure member 5 and at another end 17b connected to the front-end member 7, as illustrated schematically in Fig. 2a.

When the front-end member 7 is moved forwardly to the forward position each of the telescopic structures 17 of the energy absorbing device 15 is moved to an extended position, as illustrated by arrow B in Fig. 2b. The energy absorbing device 15 is thus movable to an extended state, illustrated in Fig. 1b and in Fig. 2b, in which it is able to deform plastically and absorb energy by the plastic deformation. In the extended state the energy absorbing device 15 may thus absorb energy during an impact with, e.g, a pedestrian 13 or a cyclist.

Fig. 1c illustrates an impact with a pedestrian 13. At the moment when the pedestrian 13 is hit by the vehicle 1 the front-end member 7 has been moved to the forward position and the energy absorbing device 15 has been extended to the extended state. The front-end member 7, which is fixed to a portion of each of the telescopic structures 17, is locked in the forward position. To this end the safety arrangement 3 comprises a locking device (not shown) capable of locking the front-end member in a forward position. The front-end member 7 is thus locked in the forward position creating an energy absorbing distance. As one or more of the telescopic structures 17 of the energy absorbing device 15 deforms, the energy absorbing device 15 absorbs energy from the pedestrian 13, slowing the pedestrian 13 down gradually and thus minimizing injury to the pedestrian 13.

Now referring to Figs. 2a and Fig. 2b, which schematically illustrate one of the telescopic structures 17, the energy absorbing device 15 will be further described.

Each telescopic structure 17 comprises an outer tube 19, which is attached to the vehicle structure member 5, and an inner tube 21 telescoped into the outer tube 19. As schematically illustrated in Fig. 2a the front-end member 7 is secured to the inner tube 21. The release device 6 comprises a breakable engaging element, in the form of a breakable engagement pin 23, which is arranged to, under normal conditions, prevent the telescopic structure 17 from assuming the extended state by locking the inner tube 21 to the outer tube 19.

Under normal conditions the breakable pin 23 thus locks the inner tube 21 to the outer tube 19 and prevents relative movement between them. Upon heavy braking of the vehicle 1 the inner tube 21 applies, due to inertia forces, a force on the breakable pin 23. Since the outer tube 19 of the telescopic structure 17 is fixed to the vehicle structure member 5, the breakable pin 23 is then subjected to a shear force that will break the pin 23 when a predetermined force, corresponding to a predetermined deceleration of the vehicle, is exceeded. In this case the breakable pin 23 has a weakened portion 23a which is configured to break when a predetermined force is exceeded. The release device 6, 23 is thus designed to release the inner tube 21, and the front-end member 7 which is attached thereto, when the vehicle deceleration exceeds a predetermined level, such as, e.g., 1g.

Each telescopic structure 17 is provided with such a breakable engaging element 23.

When the breakable pin 23 is broken movement of the telescopic structure 17 to an extended state is enabled. Hence, the inner tube 21 of the telescopic structure 17 is then free to move forwardly in the vehicle forward direction relative to the outer tube 19, as illustrated by arrow B in Fig. 2b. The inner tube 21, which is moved forwardly in the vehicle forward direction by inertia forces during the braking event, is moved to an extended position, illustrated in Fig. 2b, in which it is locked by a tube locking mechanism (not shown). The tube locking mechanism, which, e.g., may be of the type described in US 6,302,458, is capable of locking the inner tube 21 to the outer tube 19 in the extended position and is thus configured to prevent relative movement between the inner and the outer tube in the extended state, i.e. when the inner tube 21 is situated in the extended position. In the extended state, illustrated in Fig. 2b, the self-locking telescopic structure 17 forms an energy absorbing element which is configured for absorbing energy during a collision with a pedestrian 13 in order to minimise injury to the pedestrian.

Each telescopic structure 17 is provided with a tube locking mechanism capable of locking the inner tube 21 to the outer tube 19 in the extended position. The tube locking mechanisms together form the locking device of the safety arrangement 3.

Figs. 3a-c illustrates a release device 122 of a safety arrangement according to a second embodiment of the present disclosure. Essentially all features disclosed in the first embodiment are also present in the second embodiment with reference numerals identifying similar or same features.

5 Having mentioned this, the description will focus on explaining the differing features.

A pedestrian in front of a vehicle may be detected by a pre-crash sensor based detection system. In this embodiment the vehicle provided with the safety arrangement comprises a pre-crash sensor which is connected to a
10 control unit of the vehicle. The pre-crash sensor may be mounted at the front of the vehicle and configured to sense when the vehicle is expected to crash into a pedestrian.

The safety arrangement according to this embodiment differs in that it comprises an active release device 122. The active release device 122
15 comprises a pivotally arranged engaging element 123 which is arranged to, under normal conditions, prevent a telescopic structure 17 of the energy absorbing device 115 from assuming the extended state by engaging each of the outer tube 19 and the inner tube 21, as illustrated in Fig. 3a. The active release device 122 further comprises an actuator, in the form of a servomotor
20 124 having a rod 126. The motor rod 126 is arranged to hold the engaging element 123, to keep the engagement with each of the outer tube 19 and the inner tube 21, i.e. to maintain the engaging element 123 in a locking position. Hence, in the locking position, illustrated in Fig. 3a, the engaging element 123 locks the inner tube 21 to the outer tube 19, thereby preventing relative
25 displacement between the tubes 19, 21 of the telescopic structure 17. Upon activation of the release device 122 the motor rod 126 is retracted, as illustrated by arrow C in Fig. 3b, which enables the engaging element 123 to pivot away from the engagement with the tubes 19, 21, as illustrated by arrow D in Fig. 3b, as the inner tube 21 is moved toward an extended position, as
30 illustrated by arrow E in Fig. 3b and Fig. 3c.

Each telescopic structure 17 of the energy absorbing device 115 is provided with such a engaging element 123.

As long as no collision is sensed by the pre-crash sensor system the engaging elements 123 of the active release device 122 prevents the energy absorbing device 115 from extending to an extended state.

When a collision with a pedestrian is sensed by the sensor system an activation signal is generated and transmitted to the active release device 122 to activate the same.

Upon activation of the active release device 122, each engaging element 123 is released from the locking position by a respective actuator 124. Then, the energy absorbing device is free to move to the extended state by inertia forces during the braking event.

Each actuator 124, 126 is thus adapted to maintain an engaging element 123 in a locking position, in which it locks an inner tube 21 to an outer tube 19, and, in response to an activation signal, release the engaging element 123 from the locking position. The active release device 122 is thus arranged to, upon a signal indicative of a collision with a pedestrian, release the energy absorbing device 115 from a locked state.

Figs. 4a-c illustrate a release device 222 of a safety arrangement according to a third embodiment of the present disclosure. Essentially all features disclosed in the second embodiment are also present in the second embodiment with reference numerals identifying similar or same features. Having mentioned this, the description will focus on explaining the differing features.

The safety arrangement according to the third embodiment differs in that the active release device 222 comprises a linear pyrotechnical actuator 224 instead of an electric servo motor and in that the engaging element 223, which has the shape of a truncated cone, is arranged for linear displacement from a locking position, illustrated in Fig. 4a. The linear pyrotechnical actuator 224 comprises a piston 226 which is arranged to, upon activation of the pyrotechnical actuator 224, push the engaging element 223 away from the locking position, as illustrated by arrows F in Fig. 4b, thereby allowing the telescopic structure 17 to assume an extended state, as illustrated by arrow G in Fig. 4c.

Figs. 5a-c illustrate a safety arrangement 303 according to a fourth embodiment of the present disclosure. Essentially all features disclosed in the first embodiment are also present in the fourth embodiment with reference numerals identifying similar or same features. Having mentioned this, the description will focus on explaining the differing features.

The safety arrangement 303 differs in that the front-end structure 307 is pivotally connected to a vehicle structure member 305. To this end the safety arrangement 303 comprises a pivotal joint 308, illustrated in Fig. 5b. An energy absorbing device 315, which comprises two telescopic structures 17, is arranged between the front-end member 307 and the vehicle structure member 305, as illustrated in Fig. 5b. In this embodiment the front-end member 307 is thus arranged to, when the safety arrangement 303 is activated, pivot to a forward position, as illustrated by arrow H in Fig. 5b. The front-end member 307 is thus, when released by the release device, pivotable with respect to the vehicle structure member 5. In this embodiment the energy absorbing device 315 comprises two telescopic structures 117 instead of four, as described hereinbefore with reference to Figs. 1a-b.

The two telescopic structures 17 of the energy absorbing device may be of the type described hereinbefore with reference to Fig. 2a-b or of a type described hereinbefore with reference to Figs. 3a-c or of a type described hereinbefore with reference to Figs. 4a-c.

It is realized by a person skilled in the art that features from various embodiments disclosed herein may be combined with one another in order to provide further alternative embodiments.

As described hereinbefore with reference to Figs. 3a-c, the active release device of the safety arrangement comprises an actuator in the form of an electrical actuator which is arranged to operate an engaging element. It is however appreciated that the active release device may comprise another type of electric actuator, such as, e.g., an electric rotary actuator or a solenoid, or another type of actuator, such as a pneumatic actuator in the form of a gas spring, a hydraulic actuator, or a mechanical actuator, such as a preloaded spring, for operation of an engaging element.

As described hereinbefore with reference to Figs. 4a-c an active release device may comprise a pyrotechnic actuator. Such a pyrotechnic actuator may be arranged to push out, as in the described embodiment, or pull out an engaging element from engagement. The pyrotechnic actuator
5 may be activated by an electrical signal.

CLAIMS

1. A safety arrangement configured to be mounted in a vehicle (1) having a
5 front-end member (7) and a vehicle structure member (5) to which the front-
end member (7) is releasably connected,
 c h a r a c t e r i z e d in comprising
 an energy absorbing device (15) arranged between said front-end
member (7) and said vehicle structure member (5) as seen in a vehicle
10 forward direction,
 a release device (6; 122; 222) arranged to, upon heavy braking,
release said front-end member (7) to allow the front-end member (7) to be
moved forwardly in the vehicle forward direction by inertia forces during the
heavy braking, and
15 a locking device capable of locking the front-end member in a forward
position, wherein a pedestrian or a cyclist (13) that is impacted by the front-
end member (7) deforms the energy absorbing device (15; 115; 215).
2. Safety arrangement according to claim 1, wherein said energy absorbing
20 device (15; 115; 215) is extendible.
3. Safety arrangement according to claim 2, wherein said energy absorbing
device (15; 115; 215) comprises at least one telescopic structure (17).
- 25 4. Safety arrangement according to claim 3, wherein said at least one
telescopic structure (17) comprises an outer tube (19) and an inner tube (21)
telescoped into the outer tube (19).
5. Safety arrangement according to any of the preceding claims, wherein the
30 front-end member (7) is arranged to move linearly in the vehicle forward
direction.

6. Safety arrangement according to claim 5, wherein the energy absorbing device (15; 115; 215) comprises four telescopic structures (17).

7. Safety arrangement according to any of the claims 1-4, wherein the front-
5 end member (7) is pivotally connected to the vehicle structure member (5).

8. Safety arrangement according to any of the preceding claims, wherein said release device is active and comprises an actuator (124, 224) arranged to operate an engaging element (123; 223).

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9. Safety arrangement according to any of the preceding claims, wherein the release device (122; 222) comprises an actuator, preferably in the form of an electrical actuator (124, 126) or in the form of a pyrotechnical actuator (224, 226).

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10. Safety arrangement according to claim 9, wherein said release device (122) is resettable.

11. Safety arrangement according to any of the preceding claims, wherein the
20 release device (6) comprises a breakable element (23).

12. Safety arrangement according to any of the preceding claims, wherein the safety arrangement (3) comprises a pre-crash sensor system capable of sensing a pedestrian in front of the vehicle (1).

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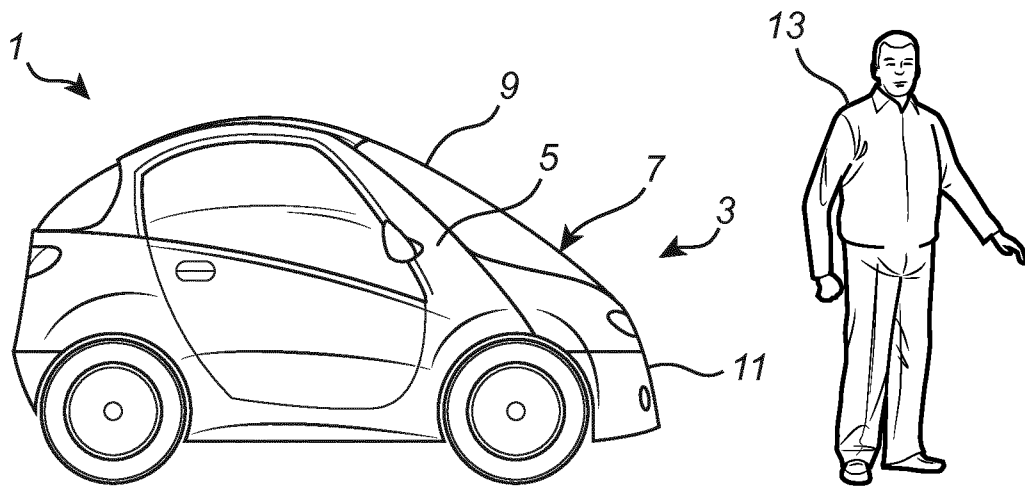


Fig. 1a

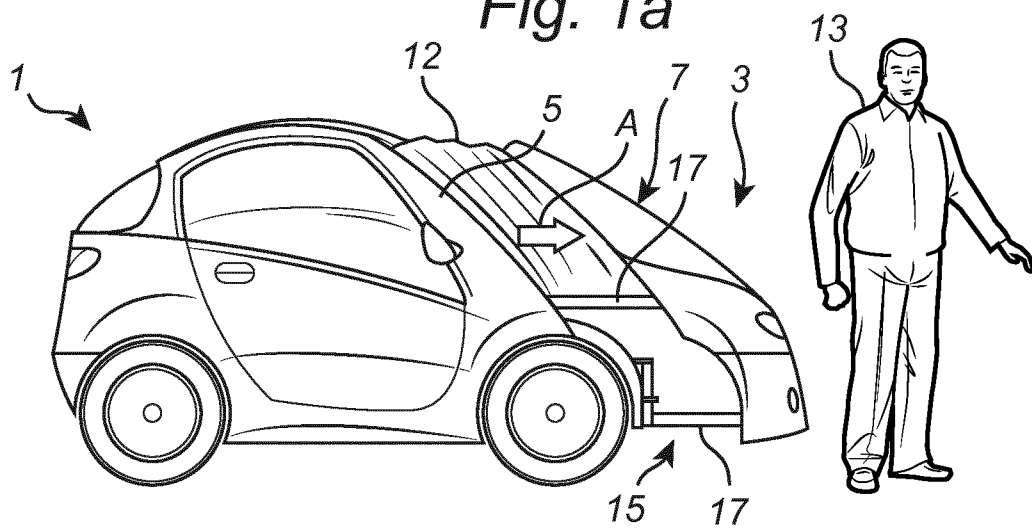


Fig. 1b

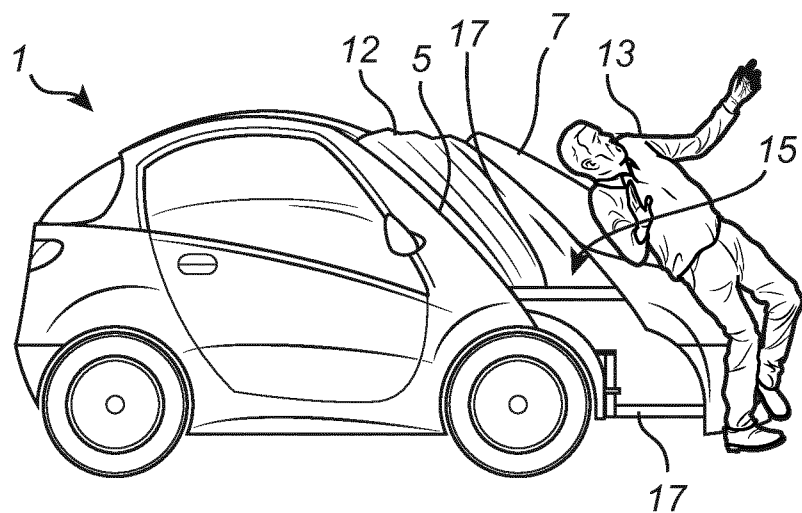


Fig. 1c

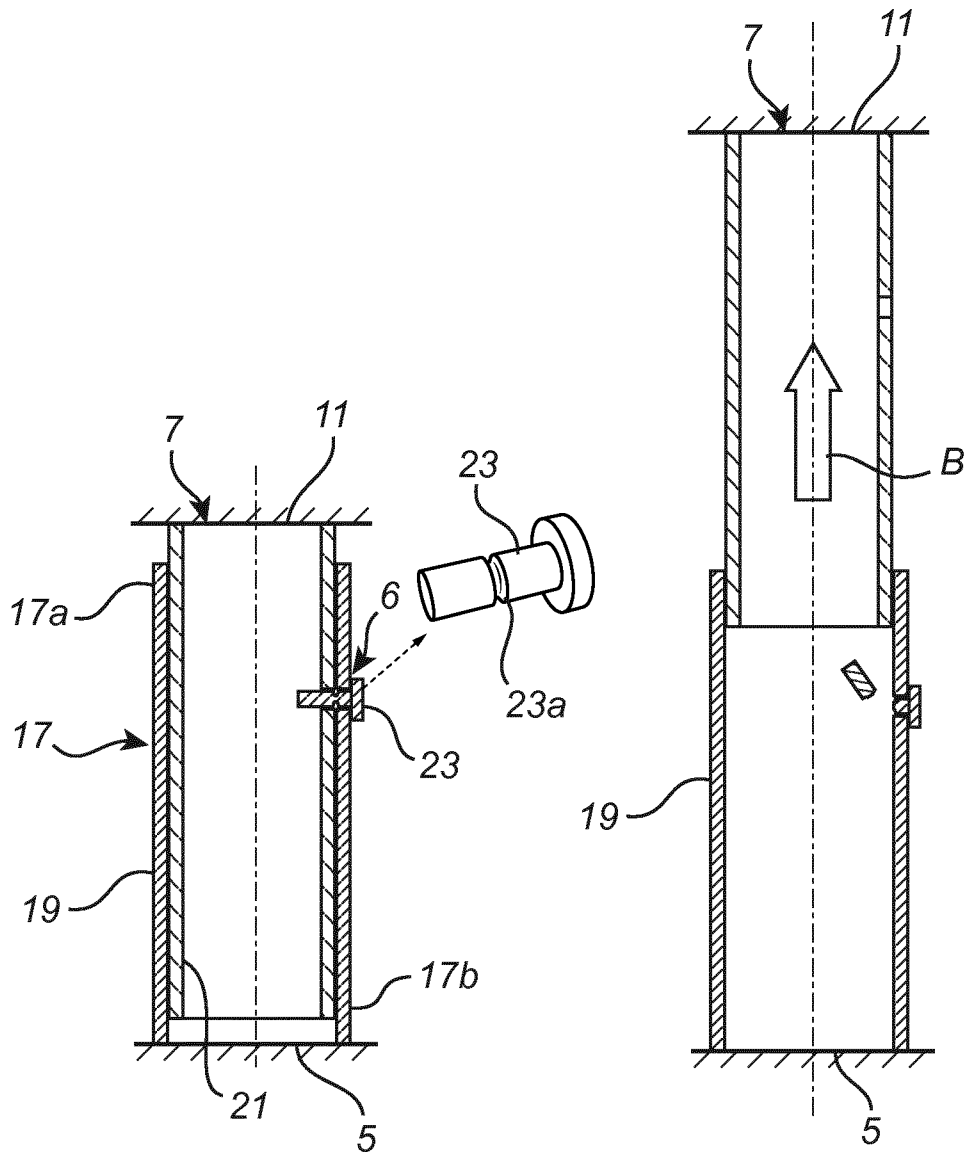
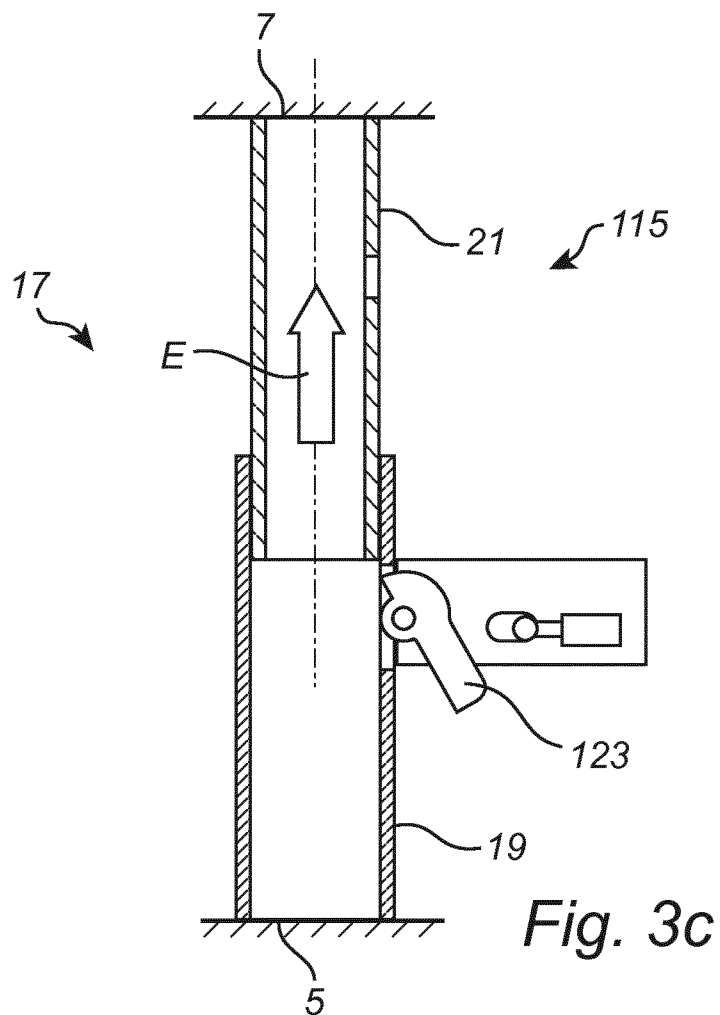
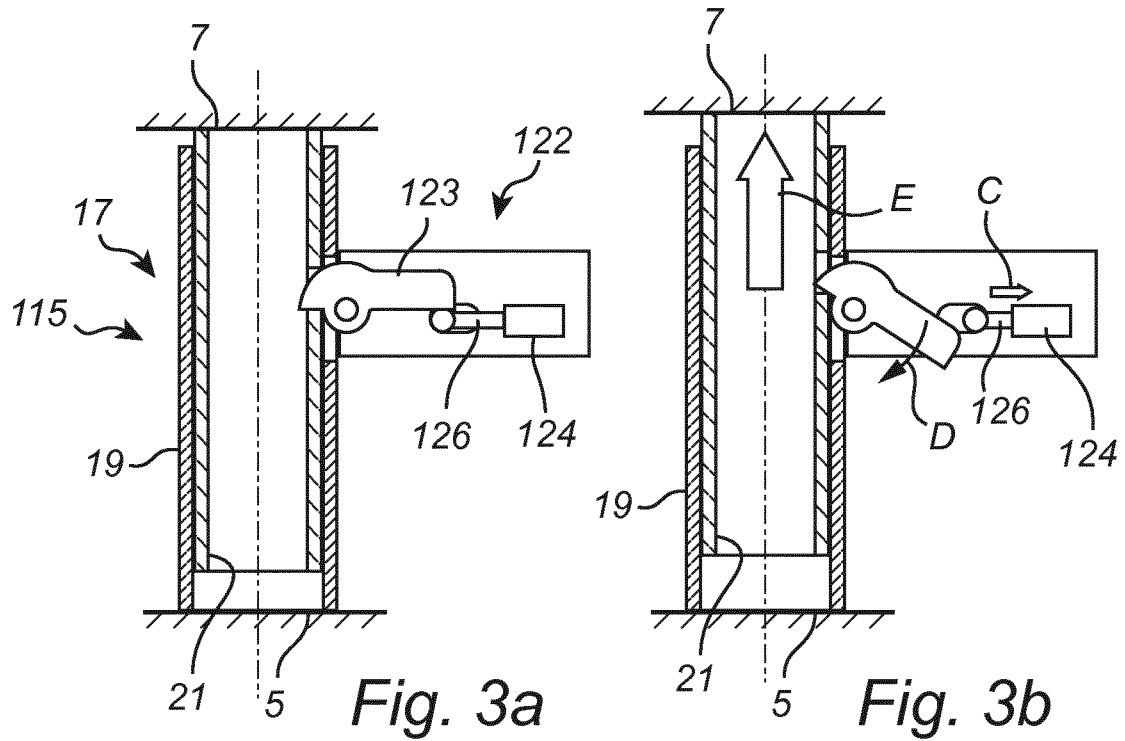


Fig. 2a

Fig. 2b



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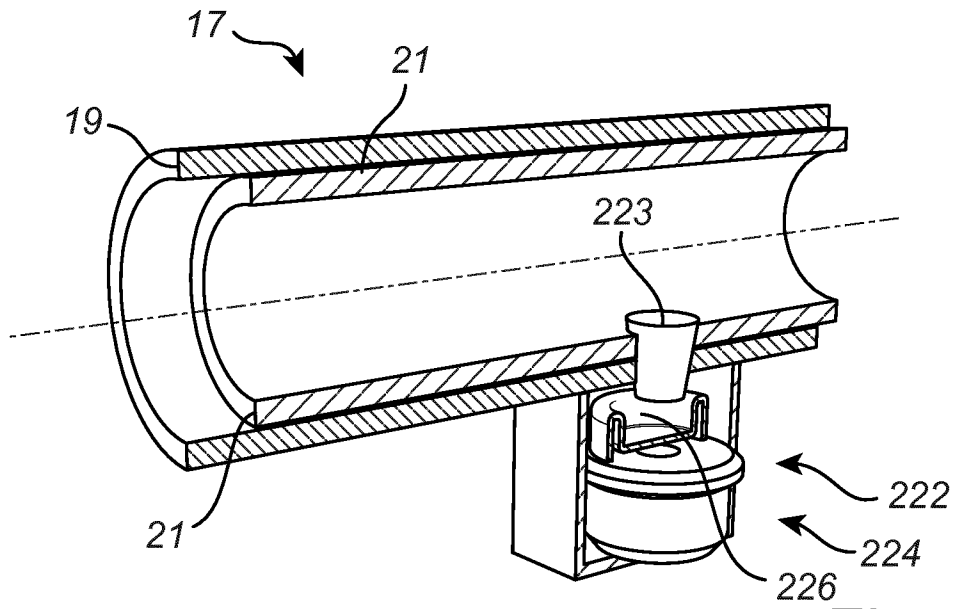


Fig. 4a

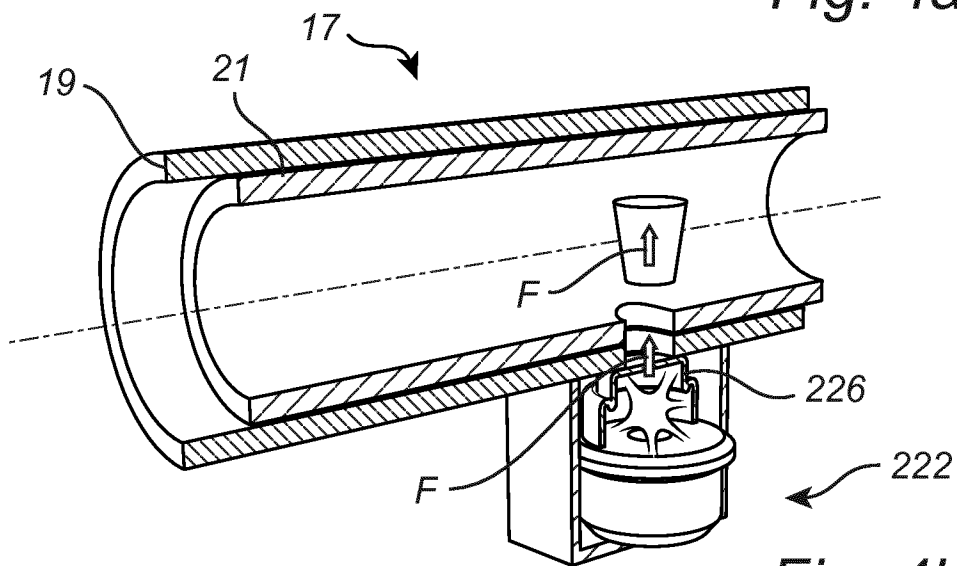


Fig. 4b

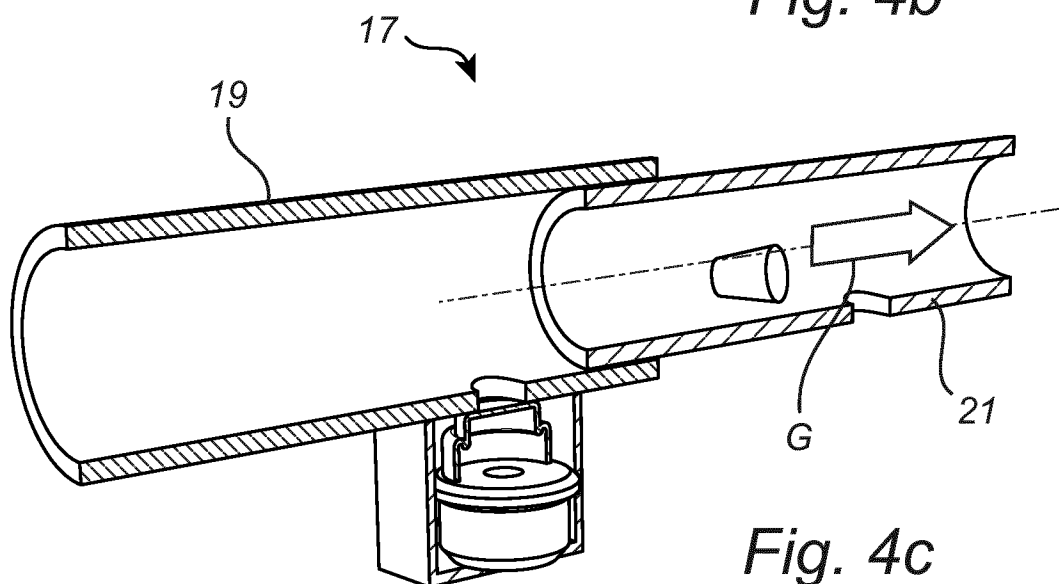


Fig. 4c

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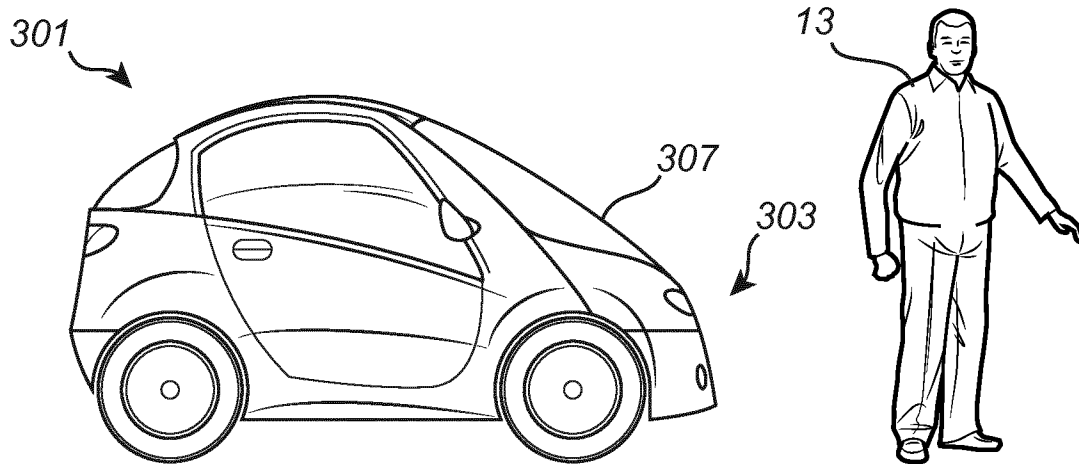


Fig. 5a

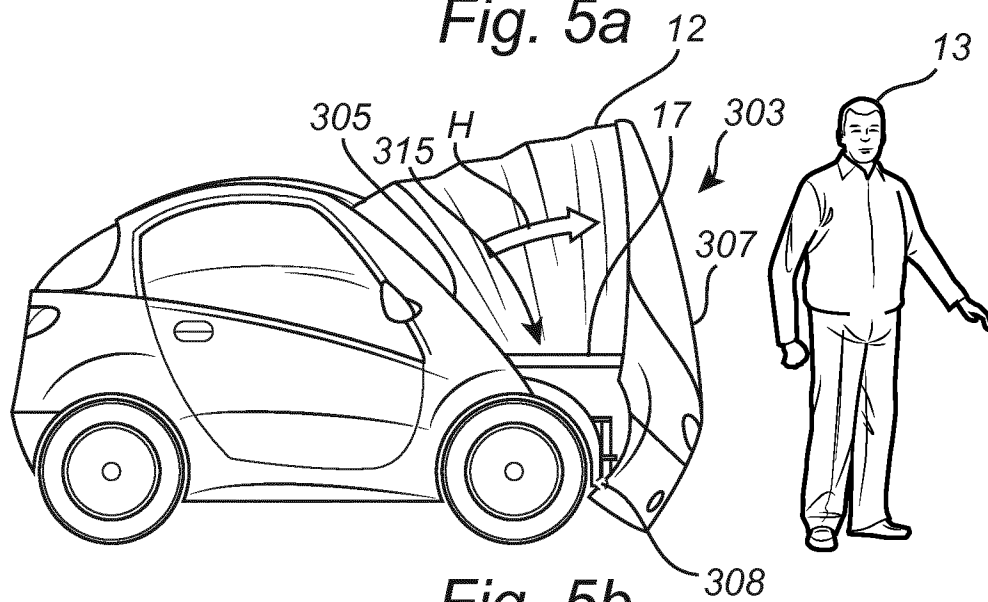


Fig. 5b

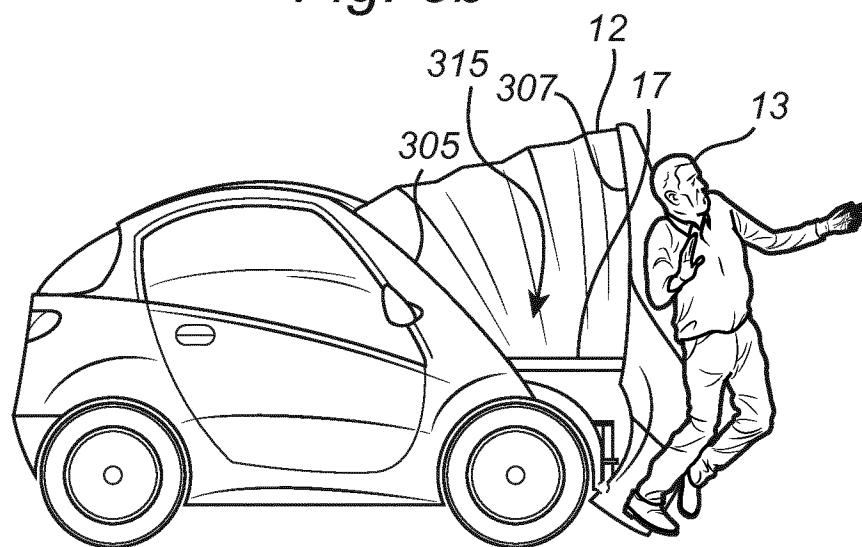


Fig. 5c

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/062020

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60R19/40 B60R21/34
ADD.

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)
B60R

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 43 37 225 A1 (KOEPPEN RUDOLF [DE]) 17 March 1994 (1994-03-17) claim 1; figure 5	1-12
Y	US 1 786 690 A (ALBERT ADDICKS) 30 December 1930 (1930-12-30) page 2, line 58 - line 72; figure 3	1-11
Y	DE 100 59 203 A1 (RACH BARBARA [DE]) 11 July 2002 (2002-07-11)	12
A	paragraph [0051]; figures	1
A	US 6 302 458 B1 (WANG JENNE-TAI [US] ET AL) 16 October 2001 (2001-10-16) abstract; figures	1
	-/--	



Further documents are listed in the continuation of Box C.



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* Special categories of cited documents :

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Date of the actual completion of the international search

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Information on patent family members

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