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(54) Title: BONNET HINGE

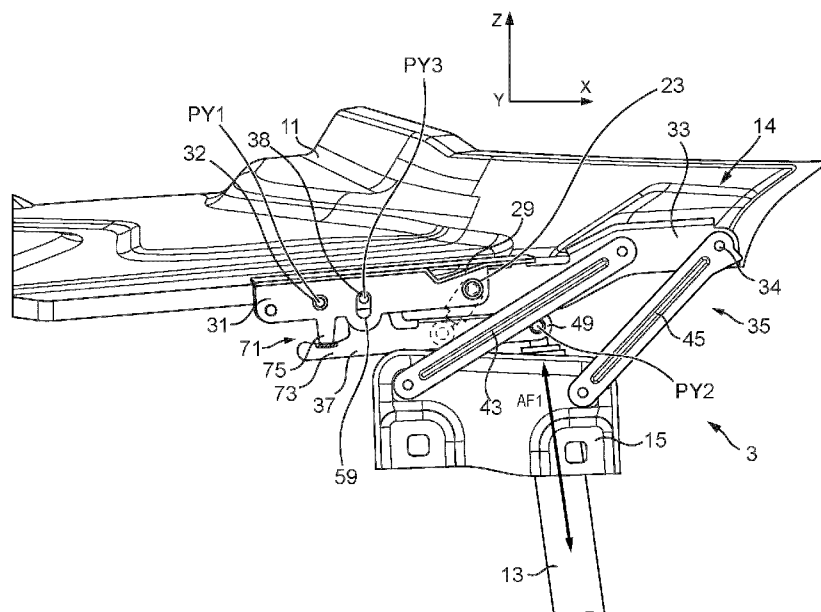


FIGURE 3

(57) Abstract: Aspects of the present invention relate to a bonnet hinge (3) for coupling a portion of a bonnet (11) to a vehicle body (5). The bonnet hinge (3) is configurable in a closed configuration for closing the bonnet (11) over a storage compartment (SC1), and an open configuration for opening the bonnet (11) to provide access to the storage compartment (SC1). The bonnet hinge (3) is also configurable in a displaced configuration for displacing the coupled portion of the bonnet (11) from the vehicle body (5). The bonnet hinge (3) a pivotable coupling (35) for connection to the vehicle body (5); a hinge arm (33) connected to the coupling (35); a bonnet mounting bracket (31) connected to the hinge arm and configured for fastening to the bonnet (11); and a control arm (37) connected to the hinge arm (33) and comprising an opening actuator attachment point (49) for receiving an opening actuator (13) to provide a normal operation force (AF1) to reversibly move the bonnet hinge (3) between the closed and open configurations. The bonnet hinge (3) has a

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lock mechanism (71) arranged to releasably maintain a geometric relationship between the bonnet mounting bracket (31), the control arm (37) and the hinge arm (33). At least one displacement actuator attachment point (55, 56) for receiving a displacement actuator (23) to provide a displacement force (DF1) to move the bonnet hinge (3) to the displaced configuration. The lock mechanism (71) substantially maintains said geometric relationship during application of the normal operation force (AF1) to pivot the coupling (35) and transition between the closed and open configurations while preventing transition to the displaced configuration. On application of the displacement force (DF1) the lock mechanism (71) releases such that said geometric relationship is not maintained and the bonnet hinge (3) transitions to the displaced configuration. Aspects of the present invention also relate to a vehicle (1) comprising a bonnet hinge (3).

BONNET HINGE**TECHNICAL FIELD**

The present disclosure relates to a bonnet hinge. Aspects of the invention relate to a bonnet hinge for coupling a portion of a bonnet to a vehicle body, a bonnet hinge assembly and a vehicle. The bonnet of a vehicle is referred to as the hood in some jurisdictions. The bonnet or hood usually covers a top opening storage compartment in the vehicle body at an end thereof, for example the front end thereof.

BACKGROUND

It is known to provide road vehicles with bonnet displacement systems which, in the event of a collision, displace the bonnet to help reduce collision forces. The bonnet displacement system may, for example, comprise a pyrotechnic actuator which applies a normal operation force to raise a portion of the bonnet. The resulting displacement is distinct from the usual opening and closing of the bonnet for access to an underneath storage compartment, for example a frunk, an engine bay or the like. The pyrotechnic actuator must operate rapidly to displace the bonnet to provide the desired operating characteristics.

A gas strut may be provided to assist with the usual opening of the bonnet. The gas strut is typically compressed when the bonnet is closed. In the event of a collision, the gas strut is extended when the pyrotechnic displacement actuator is activated. If the gas strut cannot extend sufficiently quickly, the gas strut may be damaged when the pyrotechnic displacement actuator is activated. A powered actuator (or powered strut) may be provided instead of a gas strut, for example to provide powered (driven) opening and closing of the bonnet. The powered actuator may, for example, be a powered linear actuator having an electric drive motor. The electric drive motor may, for example, rotate a lead screw to controllably extend and retract a piston or actuating arm. Unlike a gas strut, a powered actuator will resist extension. It has been recognised that the resistance applied by the powered actuator may lead to damage of the powered actuator in the event of bonnet displacement. This may be compounded by the need to mount the powered actuator such that the rate of extension is more consistent across the entire opening profile of the bonnet. This differs from gas struts which are generally mounted so that the rate of extension is very low when the bonnet is in the closed position.

It is an aim of the present invention to address one or more of the disadvantages associated with the prior art.

SUMMARY OF THE INVENTION

Aspects and embodiments of the invention provide a bonnet hinge and a vehicle as claimed in the appended claims.

According to an aspect of the present invention there is provided a bonnet hinge for coupling a portion of a bonnet to a vehicle body, the bonnet hinge being configurable in a closed configuration for closing the bonnet over a storage compartment, an open configuration for opening the bonnet to provide access to the storage compartment, and a displaced configuration for displacing the coupled portion of the bonnet from the vehicle body, the bonnet hinge comprising:

a pivotable coupling for connection to the vehicle body;
a hinge arm connected to the coupling;
a bonnet mounting bracket connected to the hinge arm and configured for fastening to the bonnet;
a control arm connected to the hinge arm and comprising an opening actuator attachment point

5 for receiving an opening actuator to provide a normal operation force to reversibly move the bonnet hinge between the closed and open configurations;

a lock mechanism arranged to releasably maintain a geometric relationship between the bonnet mounting bracket, the control arm and the hinge arm; and

10 at least one displacement actuator attachment point for receiving a displacement actuator to provide a displacement force to move the bonnet hinge to the displaced configuration,

wherein the lock mechanism substantially maintains said geometric relationship during application of the normal operation force to pivot the coupling and transition between the closed and open configurations while preventing transition to the displaced configuration, and wherein on application of the displacement force the lock mechanism releases such that said geometric relationship is not maintained
15 and the bonnet hinge transitions to the displaced configuration.

The bonnet hinge is selectively configurable in each of the closed configuration, the open configuration and the displaced configuration. In use, the normal operation force is applied selectively to configure the bonnet hinge in the closed configuration and the open configuration. In use, the displacement force is applied to
20 configure the bonnet hinge in the displaced configuration.

The application of the normal operation force to open the bonnet hinge causes the control arm to engage the hinge arm, thereby inhibiting or limiting movement of the control arm relative to the hinge arm. The application of the normal operation force to close the bonnet hinge causes the lock mechanism to inhibit or
25 to limit movement of the control arm relative to the hinge arm. The application of the displacement force releases the lock mechanism, thereby enabling movement of the control arm relative to the hinge arm. The movement of the control arm relative to the hinge arm enables the bonnet hinge to be configured to the bonnet displaced configuration. In use, the bonnet is displaced to a displaced position when the bonnet hinge is in the displaced configuration. At least in certain embodiments, the lock mechanism remains
30 engaged when the normal operation force is applied. The movement of the control arm relative to the hinge arm is inhibited or limited in dependence on the application of the normal operation force.

The control arm is moveable relative to the hinge arm in dependence on the application of the displacement force. The movement of the control arm relative to the hinge arm enables the bonnet hinge to be configured
35 in the displaced configuration.

At least in certain embodiments, the lock mechanism can be controllably released such that the geometric relationship between the bonnet mounting bracket, the control arm and the hinge arm is no longer maintained. This enables the bonnet hinge to be reconfigured to the displaced configuration. At least in
40 certain embodiments, the bonnet hinge can be reconfigured to the displaced configuration without requiring a corresponding extension of the opening actuator. The position and/or orientation of the control arm may change when the lock mechanism is released.

The lock mechanism may release (i.e., disengage) on application of the displacement force.

5 The lock mechanism may comprise a first locking member provided on the bonnet mounting bracket, and a second locking member provided on the control arm. The first and second locking members may cooperate with each other to releasably maintain said geometric relationship. On application of the displacement force, the first and second locking members may release from said cooperation to release said geometric relationship.

10 The first locking member may comprise one of a cam and a cam surface; and the second locking member may comprise the other one of the cam and the cam surface.

Alternatively, the lock mechanism may comprise a locking link member pivotally connected at respective ends to the control arm and the bonnet mounting bracket, the locking link member being configurable in an over-centre position to releasably maintain said geometric relationship. On application of the displacement force, the locking link member passes the centre position to release said geometric relationship.

20 The control arm may be pivotally connected to the hinge arm, for example by a pivot pin defining a pivot axis. On application of the displacement force, the control arm may pivot relative to the hinge arm about the pivot axis.

The hinge arm may be pivotably connected to the bonnet mounting bracket. The bonnet mounting bracket may comprises a guide aperture. The pivot pin may extend into the guide aperture to limit pivoting movement of the hinge arm relative to the bonnet mounting bracket.

25 The pivotable connection of the hinge arm and bonnet mounting bracket may be offset from the pivot axis.

The hinge arm may be connected to the vehicle body by a bonnet coupling. The bonnet coupling may comprise a fixed pivot. Alternatively, the bonnet coupling may comprise a linkage assembly. For example, the linkage assembly may comprise first and second said pivoting links. The second end of each of the first and second pivoting links may be pivotally connected to the hinge arm. The first end of each of the first and second pivoting links may be pivotably connected to a bracket which is fastenable to the vehicle body.

35 The at least one displacement actuator attachment point may comprise a first displacement actuator attachment point arranged on the bonnet mounting bracket.

The at least one displacement actuator attachment point may comprise a second displacement actuator attachment point arranged on the control arm for receiving the displacement actuator. At least in certain embodiments, the displacement actuator is positionable between the bonnet mounting bracket and the control arm.

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At least in certain embodiments, the lock mechanism and the opening actuator attachment point may be disposed on opposite sides of the pivot. The opening actuator may apply a force to engage (i.e. to lock) the lock mechanism, for example when the opening actuator applies a force to lower the bonnet.

5 The application of the normal operation force in a first direction may move the bonnet hinge from the bonnet closed configuration to the bonnet open configuration. The application of the normal operation force in a second direction may cause the bonnet hinge to move from the bonnet open configuration to the bonnet closed configuration. The normal operation force may be applied to the control arm in the first direction and/or the second direction.

10 The actuator may be a one-way actuator, such as a gas strut. The gas strut may be operable to apply the normal operation force to cause the bonnet moving assembly to move from the bonnet closed configuration to the bonnet open configuration. An external force may be applied to configure the bonnet hinge in the closed configuration. For example, the external force may be applied by a user to close the bonnet. The
15 external force may, for example, compress a gas strut.

Alternatively, the actuator may be a powered actuator. The powered actuator may comprise an electromechanical actuator. The electromechanical actuator may, for example, comprise an electric motor and a lead screw. Other types of powered actuator are contemplated. The powered actuator may be
20 operable selectively to apply the normal operation force. The powered actuator may be operable selectively to apply the normal operation force to cause the bonnet moving assembly to move from the bonnet closed configuration to the bonnet open configuration. alternatively, or in addition, the powered actuator may be operable to apply the normal operation force to cause the bonnet moving assembly to move from the bonnet open configuration to the bonnet closed configuration.

25 The displacement actuator may be a pyrotechnic actuator. Other types of displacement actuator are contemplated. In use, the displacement actuator may be connected at a first end to the connecting means provided on the bonnet mounting bracket. Alternatively, the first end of the connecting means may be connected to a separate connector provided on the bonnet. A second end of the displacement actuator
30 may be connected to the vehicle body, for example to a vehicle body member or a mounting bracket. The displacement force may be applied between the vehicle body and the bonnet. The displacement actuator may comprise a linear displacement actuator or a rotary displacement actuator.

The lock mechanism may comprise: a first locking member provided on the bonnet mounting bracket, and
35 a second locking member provided on the control arm. The first and second locking members may cooperate with each other to engage the lock mechanism. For example, the first and second locking members may engage each other to engage the lock mechanism. The movement of the first and second locking members relative to each other may be prevented or restricted when the lock mechanism is engaged.

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The lock mechanism may comprise a cam lock mechanism. The first locking member may comprise one of a cam and a cam surface. The second locking member may comprise the other one of the cam and the cam surface. The cam may engage the cam surface to engage the lock mechanism.

- 5 At least in certain embodiments, the normal operation force may cause the cam to engage the cam surface such that relative movement therebetween is inhibited or restricted, thereby engaging the lock mechanism. At least in certain embodiments, the displacement force may cause the cam to move relative to the cam surface, thereby disengaging the lock mechanism.
- 10 The cam and the cam surface may cooperate with each to engage the lock mechanism when the normal operation force is applied. The lock mechanism may release when the displacement force is applied. The application of the normal operation force may, for example, promote or encourage a pivoting movement of the control arm about a first pivot axis. When the control arm pivots about the first pivot axis, the resulting vector of movement between the cam and the cam surface is normal to the cam surface and relative
- 15 movement is inhibited or restricted (thereby engaging the lock mechanism).

- Alternatively, the lock mechanism may comprise a locking link member pivotally connected at respective ends to the control arm and the bonnet mounting bracket. The locking link member may form an over-centre lock mechanism. The locking link member may inhibit movement of the control arm relative to the hinge
- 20 arm in dependence on the normal operation force. The locking link member may enable movement of the control arm relative to the hinge arm in dependence on the displacement force.

- The control arm may be pivotally connected to the hinge arm by a second pivot pin defining a second pivot axis. In use, the application of the displacement force may cause the control arm to pivot relative to the
- 25 hinge arm about the second pivot axis. The pivoting motion of the control arm relative to the hinge arm may cause the bonnet hinge to be reconfigured from the bonnet closed configuration to the displaced configuration.

- The bonnet mounting bracket may comprise a guide aperture. The second pivot pin may extend into the
- 30 guide aperture to limit pivoting movement of the hinge arm relative to the bonnet mounting bracket. The guide aperture may comprise an arcuate profile, for example centred on the first pivot axis. The guide aperture may comprise a first end for limiting pivoting movement of the hinge arm relative to the bonnet mounting bracket in a first direction. The guide aperture may comprise a second end for limiting pivoting movement of the hinge arm relative to the bonnet mounting bracket in a second direction.

- 35 The first pivot axis may be offset from the second pivot axis.

- The linkage assembly may comprise first and second said pivoting links. The second end of each of the first and second pivoting links may be pivotally connected to the hinge arm. The first and second pivoting
- 40 links may form a four-bar linkage assembly, for example.

At least in certain embodiments, the bonnet hinge cannot readily be reconfigured from the displaced configuration to either the open configuration or the closed configuration. The bonnet hinge may be fixed or retained in the displaced configuration. The lock mechanism and/or the displacement actuator may fasten the bonnet hinge in the displaced configuration. This may help to ensure that appropriate servicing or maintenance is performed after deployment of the displacement actuator, for example to reset or replace the displacement actuator.

According to a further aspect of the present invention there is provided a bonnet assembly comprising a bonnet and a bonnet hinge as described herein.

According to a further aspect of the present invention there is provided a vehicle comprising a bonnet and a bonnet hinge as claimed in any one of the preceding claims.

The vehicle may comprise at least one opening actuator operable to generate at least one normal operation force. The at least one opening actuator may be connected at a first end to a body member of the vehicle and at a second end to the control arm.

The or each opening actuator may be mounted at a first end to a body of the vehicle, and at a second end to the control arm.

The or each opening actuator may comprise a powered actuator. The or each opening actuator may comprise a powered linear actuator.

The vehicle may comprise at least one displacement actuator operable to generate the displacement force to configure the bonnet hinge in the bonnet displaced configuration, thereby deploying the bonnet. The displacement actuator may be configured to engage the body of the vehicle to deploy the bonnet. The displacement actuator may comprise a pyrotechnic actuator.

The linkage assembly may be mounted to the body of the vehicle, for example to one or more body members.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic representation of a vehicle comprising a bonnet hinge in accordance with an embodiment of the present invention;

5 Figures 2A, 2B and 2C shows schematic representations of the bonnet of the vehicle shown in Figure 1 in a rest position, an open position and a displaced position;

Figure 3 shows a schematic representation of a bonnet hinge in accordance with an embodiment of the present invention in a closed configuration;

Figure 4 shows the bonnet hinge shown in Figure 3 in an open configuration;

10 Figure 5 shows the bonnet hinge shown in Figure 3 in a displaced configuration;

Figure 6 shows a schematic representation of the application of forces to a locking mechanism of the bonnet hinge shown in Figure 3;

Figure 7 shows a view of a second side of the bonnet hinge shown in Figure 3;

15 Figure 8 shows a schematic representation of the bonnet hinge in accordance with a further embodiment of the present invention in a closed configuration;

Figure 9 shows a schematic representation of the bonnet hinge shown in Figure 8 in a closed configuration; and

Figure 10 shows a schematic representation of the bonnet hinge shown in Figures 8 and 9 in a displaced configuration.

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DETAILED DESCRIPTION

A vehicle 1 comprising a bonnet 11 in accordance with an embodiment of the present invention is shown in Figure 1. The bonnet 11 may also be referred to as a hood. The vehicle 1 is described herein using a reference frame comprising a longitudinal axis X, a transverse axis Y and a vertical axis Z. The vehicle 1 in the present embodiment is a road vehicle having a plurality of wheels W-n. In the example shown in Figure 1, the vehicle 1 is an automobile.

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The vehicle 1 comprises a vehicle body 5 which forms a cabin 7 for occupants. The bonnet 11 may, for example, comprise a clamshell bonnet. The bonnet 11 in the present embodiment is provided to cover a storage compartment SC1 which may be referred to as a front storage compartment, a frunk, a froot or the like. The storage compartment may alternatively be an engine or motor bay for an internal combustion engine or electric drive unit (not shown). It will be understood that the bonnet hinge 3 is not limited to this particular application.

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The bonnet 11 is coupled to the vehicle body 5 through at least one bonnet hinge 3, as described herein. The at least one bonnet hinge 3 is operable to displace the bonnet 11 between a closed (rest) position (illustrated in Figure 2A) and an open position (illustrated in Figure 2B). This reversible operation between the closed and open positions is referred to as normal or usual operation in which an operator accesses and covers the storage compartment. A latch mechanism 12 may be provided to latch the bonnet 11 in the closed position. The at least one bonnet hinge 3 is operable also to displace the bonnet 11 to a displaced position (illustrated in Figure 2C). The bonnet 11 is moved to the displaced position in the event of a collision to provide improved pedestrian protection. In the displaced position, a rear portion 14 of the bonnet 11 is

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displaced upwardly, that is to say in a positive direction along the vertical axis Z. The upward displacement of the rear portion 14 of the bonnet 11 may comprise or consist of a pivoting motion of the bonnet 11, for example about the latch mechanism 12 provided at the front of the bonnet 11. Alternatively, the upward displacement of the rear portion 14 of the bonnet 11 may comprise or consist of a translational motion of the bonnet 11. The upward displacement of the rear portion 14 of the bonnet 11 may comprise a combination of a pivoting and translational motion.

It will be appreciated that in examples of the invention, the vehicle 1 comprises first and second bonnet hinges 3 to couple the bonnet 11 to the vehicle body 5. The first and second bonnet hinges 3 may have like configurations. The first and second bonnet hinges are positioned on opposing sides of the bonnet 11, that is to say they are offset in the transverse axis Y. The first and second bonnet hinges 3 are therefore, in some embodiments, mirror images of each other. For the sake of brevity, only one of the bonnet hinges 3 is described herein.

The bonnet hinge 3 according to an embodiment of the invention is shown in Figure 3. The bonnet hinge 3 comprises a bonnet mounting bracket 31, a hinge arm 33; a bonnet coupling 34; and a control arm 37. The bonnet mounting bracket 31 is arranged for fastening to the bonnet 11. That is to say the bracket 31 has bolt mounting points, weld locations, or the like, which allow for the bonnet 11 to be fastened to the bonnet mounting bracket 31. In turn, the bonnet mounting bracket 31 is connected to the hinge arm 33. The connection is through a first pivot point 32. The hinge arm 33 is pivotally connected to the bonnet mounting bracket 31 by a first pivot pin 41 defining a first pivot axis PY1.

A coupling 35 pivotably couples the hinge arm 33 to the vehicle body 5. The coupling 35 is configured to control the movement of the bonnet 11 between the closed position and the open position. The coupling 35 in the present embodiment is in the form of a linkage assembly 35. The linkage assembly 35 is configured to mount the hinge arm 33 to at least one body member 15. The at least one body member 15 may be in the form of a mounting bracket. The linkage assembly 35 comprises first and second pivoting links 43, 45. The first and second pivoting links 43, 45 form part of a four-bar linkage. The first end of each of the first and second pivoting links 43, 45 is pivotally connected to the body member 15. The second end of each of the first and second pivoting links 43, 45 is pivotally connected to the hinge arm 33. The geometry of the linkage assembly 35 can be adjusted to control the position and orientation of the hinge arm 33, thereby controlling the position and orientation of the bonnet 11. The linkage assembly 35 advantageously translates the bonnet 11 as it rotates the bonnet so that the bonnet moves away or up to neighbouring vehicle components (not shown) as it opens or closes respectively. The coupling 35 could be configured such that the hinge arm 33 undergoes only a rotational movement. In other arrangements the hinge arm 33 may be directly coupled to the vehicle body 5 via a pivot, for example at the point marked by numeral 34 in Figure 3.

An opening actuator 13 is provided for applying a normal operating force AF1 to reversibly open and close the bonnet 11. The opening actuator 13 is connected to an end of the control arm 37. The control arm 37 comprises an opening actuator attachment point 49 for receiving the opening actuator 13. The opening actuator attachment point 49 is configured to pivotally connect the opening actuator 13 to the control arm

37. The opening actuator attachment point 49 comprises a connector, for example comprising a connecting pin or a connecting member disposed in an aperture, a bearing or a bushing. The opening actuator attachment point 49 in the present embodiment comprises a second pivot pin 50 defining a second pivot axis PY2 (shown in Figures 6 and 7). The second pivot pin 50 pivotally connects the control arm 37 and the piston rod 17 of the opening actuator 13.

The control arm 37 is pivotally connected to the hinge arm 33. The connection is through a third pivot point 38. The third pivot point 38 comprises a third pivot pin 57 (shown in Figures 6 and 7). The third pivot pin 57 defines a third pivot axis PY3. The third pivot pin 57 projects into a guide aperture 59 formed in the bonnet mounting bracket 31 (shown in Figures 3, 4 and 5). The guide aperture 59 is operative to limit pivoting movement of the hinge arm 33 relative to the bonnet mounting bracket 31. The guide aperture 59 may have a linear profile. Alternatively, the guide aperture 59 may have an arcuate profile centred on the first pivot axis PY1. As shown in Figure 7, the guide aperture 59 has first and second ends 61A, 61B which function as stops to limit pivoting movement of the hinge arm 33 relative to the bonnet mounting bracket 31. In use, the first end 61A of the guide aperture 59 limits pivoting movement of the hinge arm 33 relative to the bonnet mounting bracket 31 in a first direction. In use, the second end 61B of the guide aperture 59 limits pivoting movement of the hinge arm 33 relative to the bonnet mounting bracket 31 in a second direction. In a variant, a separate guide pin (not shown) may be provided on the hinge arm 33 for locating in the guide aperture 59, rather than the end portion of the third pivot pin 57. The guide pin may be spaced apart from the third pivot pin 57, for example closer to or further away from the first pivot axis PY1.

A lock mechanism 71 is provided and arranged to releasably maintain a geometric relationship between the bonnet mounting bracket 31, the control arm 37 and the hinge arm 33. When engaged, the lock mechanism 71 maintains the bonnet mounting bracket 31, the control arm 37 and the hinge arm 33 in a fixed geometric relationship. The lock mechanism 71 in the present embodiment is configured to maintain the geometric relationship between the bonnet mounting bracket 31, the control arm 37 and the hinge arm 33 as the bonnet hinge 3 is displaced from the open configuration to the closed configuration. Alternatively, or in addition, the lock mechanism 71 may be configured to maintain the geometric relationship between the bonnet mounting bracket 31, the control arm 37 and the hinge arm 33 as the bonnet hinge 3 is displaced from the closed configuration to the open configuration.

In the present embodiment, the lock mechanism 71 comprises a first locking member 75 provided on the bonnet mounting bracket 31, and a second locking member 73 provided on the control arm 37. The first and second locking members 75, 73 cooperate with each other to releasably maintain said geometric relationship. The first locking member 75 is a cam 75 in the example shown and the second locking member 73 is a cam surface 73. The cam 75 and the cam surface 73 are configured to engage each other to prevent movement of the control arm 37 relative to the bonnet mounting bracket 31. When the lock mechanism 71 is dis-engaged, movement of the control arm 37 relative to the hinge arm 33 is enabled. The cam surface 73 comprises a concave surface for controlling movement of the cam 75. The first locking member 75 and the second locking member 73 engage at a contact point 50" (as shown in Figure 4). It will be appreciated that the cam 75 and the cam surface 73 can be interchanged.

The opening actuator 13 is operable to apply a normal operation force AF1 to reversibly move the bonnet hinge 3 between the closed and open configurations, thereby opening and closing the bonnet 11. On application of the normal operation force AF1 to open the bonnet hinge 3 from the closed configuration shown in Figure 3 to the open configuration shown in Figure 4, the lock mechanism 71 maintains the geometric relationship between the bonnet mounting bracket 31, the control arm 37 and the hinge arm 33. The bonnet mounting bracket 31, the control arm 37 and the hinge arm 33 are retained in a fixed geometric relationship by the lock mechanism 71. The normal operation force AF1 is thereby translated into movement of the bonnet hinge 3 by the bonnet coupling 34. This is shown by reference to Figure 3 and 4 where it is observed that through normal operation of the bonnet hinge 3, the bonnet mounting bracket 31, the control arm 37 and the hinge arm 33 remain in a substantially fixed position with respect to each other. This feature of the invention is described with reference to rotational arrow AR1 and supporting numerals 50' and 50". Rotational arrow AR1 is shown around the pivot connection between the control arm 37 and the hinge arm 33.

The application of the normal operation force AF1 in a positive Z direction, that is to say upwards to lift the bonnet 11, encourages an anticlockwise rotation 50 about the third pivot axis PY3 (in the orientation shown in Figures 3 and 4). However, interference between an upper surface 52 of the control arm 37 and a lower surface 54 of the hinge arm 33 (illustrated at an engagement point 50') resists said anticlockwise rotation. The movement of the control arm 37 relative to the hinge arm 33 is prevented. The normal operation force AF1 applied by the opening actuator 13 is transmitted to the hinge arm 33. The application of the normal operation force AF1 causes the control arm 37 and the hinge arm 33 to be displaced together in a fixed geometric relationship. The linkage assembly 35 is reconfigured such that the hinge arm 33 is displaced upwardly and undergoes rotation. The normal operation force AF1 thereby re-configures the bonnet hinge 3 from the bonnet closed configuration (shown in Figure 3) to the bonnet open configuration (shown in Figure 4).

The application of the normal operation force AF1 in a negative Z direction, that is to say downwards to lower the bonnet 11, encourages a clockwise rotation about the third pivot axis PY3 (in the orientation shown in Figures 3 and 4). The lock mechanism 71 resists (through interference at the contact point 50" of the cam 75 and the cam surface 73) said clockwise rotation. The lock mechanism 71 thereby prevents rotation of the hinge arm 33 and the control arm 37 relative to each other. The control arm 37 reacts about the third pivot axis PY3, such that the second locking member 73 applies a reactive force to the first locking member 75 along a first vector of movement MV1 (shown in Figure 6). The lock mechanism 71 thereby resists or prevents rotation of the control arm 37 relative to the hinge arm 33. The application of the normal operation force AF1 causes the control arm 37 and the hinge arm 33 to be displaced together in a fixed geometric relationship. The linkage assembly 35 is reconfigured such that the hinge arm 33 is displaced downwardly and undergoes rotation. The application of the normal operation force AF1 thereby re-configures the bonnet hinge 3 from the bonnet open configuration (shown in Figure 4) to the bonnet closed configuration (shown in Figure 3).

In the present embodiment, the opening actuator 13 is a powered actuator which is operable also to displace the bonnet 11 from the open position to the closed position. The opening actuator 13 may, for

example, be an electric linear actuator comprising an electric motor (not shown) operable to displace a piston rod 17 in a linear direction. The electric motor may, for example, drivingly rotate a lead screw (not shown) to actuate the piston rod 17. The rotational direction of the electric motor can be reversed selectively to extend and retract the piston rod 17. The electric motor is coupled to a gear box (not shown). The opening actuator 13 may optionally also comprise a clutch. The opening actuator 13 may optionally comprise a brake (active and/or passive) between the electric motor and lead screw to provide mechanical advantage and/to ensure that the bonnet 11 can be held in a predetermined orientation. In certain embodiments, the opening actuator 13 may comprise a disconnect mechanism operable to protect against forces applied perpendicular to a longitudinal axis.

A controller (not shown) may be provided to control operation of the opening actuator 13 to ensure that the bonnet 11 opens and closes at a predetermined speed. The first and second directions are applied along a longitudinal axis of the opening actuator 13 and are opposite to each other. The opening actuator 13 is mounted to a body member (denoted generally by the reference numeral 15) of the vehicle 1. The opening actuator 13 pivots relative to the body member 15 as the piston rod 17 extends and retracts. The opening actuator 13 in the present embodiment is connected to the body member 15 by a ball joint to enable rotation about more than one axis. Other mounting arrangements are contemplated to provide one or more degrees of freedom for the opening actuator 13. For example, a slider-rocker mechanism may be used to mount the opening actuator 13. In a variant, the opening actuator 13 may be configured to apply a force in only one direction, for example to apply the normal operation force AF1 to displace the bonnet 11 from the closed (rest) position to the open position. The opening actuator 13 may comprise a gas strut or a mechanical spring strut. The opening actuator 13 can store potential energy, for example by compressing gas in a chamber in the gas strut, when the bonnet 11 is manually closed.

A displacement actuator 23 (shown schematically in Figure 5, 7 and 8) is provided to displace the bonnet hinge 3 to the displaced position. The displacement actuator 23 is typically operable to displace the bonnet hinge 3 from the closed configuration (shown in Figure 3) to the displaced configuration (shown in Figure 5). The displacement actuator 23 is a pyrotechnic actuator (also known as an explosive piston actuator). The displacement actuator 23 comprises a gas generator 25 (or a pressure cartridge) which drives a displacement piston 27 to generate a displacement force DF1. The displacement force DF1 is applied along a longitudinal axis of the displacement actuator 23. The gas generator 25 is activated in conventional manner in response to an electrical signal generated by a collision detection unit (not shown). Other types of displacement actuator 23 are contemplated. The displacement piston 27 undergoes a translational motion when the displacement actuator 23 is deployed. In a variant, the displacement piston 27 may undergo a rotational motion when the displacement actuator 23 is deployed. The displacement force DF1 generated by the displacement actuator 23 may be applied to the bonnet 11 or the bonnet mounting bracket 31.

The displacement actuator 23 is connected between the bonnet mounting bracket 31 and the control arm 37. The bonnet mounting bracket 31 comprises a first displacement actuator attachment point 55 for receiving the displacement actuator 23 to transmit the displacement force DF1 to the bonnet hinge 3. A second displacement actuator attachment point 56 is arranged on the control arm 37 for receiving the

displacement actuator 23 so that the displacement actuator 23 can be positioned between the bonnet mounting bracket 31 and the control arm 37. The second displacement actuator attachment point 56 is spaced apart from the opening actuator attachment point 49 provided on the control arm 37.

5 The displacement force DF1 is transmitted to the bonnet mounting bracket 31 to re-configure the bonnet hinge 3 to the displaced configuration. The application of the displacement force DF1 biases the bonnet mounting bracket 31 and the control arm 37 apart. The bonnet mounting bracket 31 and the hinge arm 33 are pivotable relative to each other about the first pivot axis PY1; and the hinge arm 33 and the control arm 37 are pivotable relative to each other about the third pivot axis PY3. The first pivot axis PY1 and the third
10 pivot axis PY3 are offset from each other. In the orientation shown in Figure 5, the displacement force DF1 encourages a counterclockwise rotation of the bonnet mounting bracket 31 about the first pivot axis PY1. The rotation of the bonnet mounting bracket 31 displaces the cam 75 relative to the cam surface 73, thereby enabling the rotation of the control arm 37 about the first pivot axis PY1 (in a counterclockwise direction in the orientation shown in Figure 5). The bonnet mounting bracket 31 reacts about the first pivot axis PY1,
15 such that the cam 75 is displaced along the cam surface 73. The direction of travel of the cam 75 is represented by a second vector of movement MV2 in Figure 6.

The displacement of the cam 75 disengages the lock mechanism 71 such that the control arm 37 and the bonnet mounting bracket 31 can pivot relative to the hinge arm 33. The control arm 37 remains pivotably
20 connected to the opening actuator 13. However, the control arm 37 is pivotable relative to the hinge arm 33 about the third pivot axis PY3. This enables the bonnet hinge 3 to be configured in the displaced configuration without an associated change in the effective length of the opening actuator 13. As shown in Figure 5, the displacement force DF1 is effective in displacing the hinge arm 33 upwardly, thereby elevating a rear portion of the bonnet 11.

25 In the present embodiment, the application of the displacement force DF1 causes the bonnet mounting bracket 31 to rotate relative to the hinge arm 33 about the first pivot axis PY1 in a counter clockwise direction (in the orientation shown in Figure 5). The offset between the first and third pivot axis PY1, PY3 causes the bonnet mounting bracket 31 to undergo translation and rotation relative to the control arm 37. The
30 translation of the bonnet mounting bracket 31 and the control arm 37 relative to each other is accommodated by the movement of the third pivot pin 57 within the guide aperture 59. This results in a change in the position and/or orientation of the cam 75 relative to the cam surface 73. The change in relative position and/or orientation facilitates movement of the cam 75 along the cam surface 73 when the displacement force DF1 is applied.

35 The bonnet hinge 3 cannot readily be returned to a normal operating configuration from the displaced configuration. The lock mechanism 71 and/or the displacement actuator 23 is configured to resist returning the bonnet hinge 3 to either the closed configuration or the open configuration. In the arrangement shown in Figure 5, the bonnet mounting bracket 31 cannot be rotated in a clockwise direction relative to the control
40 arm 37 to return the bonnet hinge 3 to the closed configuration.

The bonnet hinge 3 according to the present embodiment is selectively configurable in each of the following configurations:

- (i) a bonnet closed configuration (shown in Figure 3) to displace the bonnet 11 to the closed position;
- 5 (ii) a bonnet open configuration (shown in Figure 4) to displace the bonnet 11 to the open position; and
- (iii) a bonnet displaced configuration (shown in Figures 5 and 7) to displace the bonnet 11 to the displaced position.

The opening actuator 13 is operable selectively to configure the bonnet hinge 3 in the bonnet closed configuration and the bonnet open configuration. The displacement actuator 23 is operable to configure the bonnet hinge 3 in the bonnet displaced configuration. In use, the control arm 37 and the opening actuator 13 are pivotable relative to each other to accommodate changes in their relative orientation as the piston rod 17 extends and retracts. The control arm 37 is configured to transmit the normal operation force AF1 applied by the opening actuator 13 to the hinge arm 33. The displacement actuator 23 applies a displacement force DF1 to pivot the bonnet mounting bracket 31 relative to the hinge arm 33, thereby disengaging the lock mechanism 71 and enabling pivoting movement of the control arm 37 relative to the hinge arm 33.

The lock mechanism 71 in the above embodiment has been described as comprising first and second locking members 73, 75 in the form of a cam 75 and a cam track 73. It will be understood that other types of lock mechanism 71 may be implemented. A further embodiment of the bonnet hinge 3 in accordance with an aspect of the present invention will now be described with reference to Figures 8 to 10. For the sake of brevity, the description herein focuses on the differences between the embodiments of the bonnet hinge 3. Like reference numerals are used for like components.

The bonnet hinge 3 comprises a lock mechanism 71 in the form of an over-centre lock. The lock mechanism 71 comprises a locking link member 81 having a first end 83A pivotally connected to the bonnet mounting bracket 31; and a second end 83B pivotally connected to the control arm 37. A fourth pivot pin 85 defines a fourth pivot axis PY4 for pivotally connecting the first end 83A of the locking link member 81 to the bonnet mounting bracket 31. A fifth pivot pin 87 defines a fifth pivot axis PY5 for pivotally connecting the second end 83B of the locking link member 81 to the control arm 37.

The lock mechanism 71 is engaged when the opening actuator 13 operates to apply the normal operation force AF1. The re-configuration of the bonnet hinge 3 between the closed configuration (shown in Figure 8) and the open configuration (shown in Figure 9) is unchanged from the arrangement described herein with reference to Figures 1 and 7. The application of the normal operation force AF1 in an upwards direction, that is to say in a positive direction along the vertical axis Z, causes the control arm 37 to rotate in a first direction (clockwise in Figure 9) and engage the hinge arm 33, thereby inhibiting relative movement of the control arm 37 and the hinge arm 33. The application of the normal operating force AF1 in a downwards direction, that is to say in a negative direction along the vertical axis Z, causes the hinge arm 33 to rotate in a second direction (counterclockwise in Figure 9) which biases the locking link member 81 towards a locked position, thereby engaging the lock mechanism 71 (or holding the lock mechanism 71 in an engaged

position) which inhibits rotation of the hinge arm 33 about the first pivot axis PY1. As shown in Figure 10, the application of the displacement force DF1 by the displacement actuator 23 causes rotation of the locking link member 81, thereby disengaging the lock mechanism 71. In the present embodiment, the control arm 37 is driven to the displaced configuration by the application of the displacement force DF1, as shown in Figure 7. In particular, the application of the displacement force DF1 causes the control arm 37 and the hinge arm 33 to pivot apart. Once the displacement actuator 23 is deployed, the locking link member 81 is unlocked, thereby enabling relative movement of the control arm 37 and the bonnet mounting bracket 31. The displacement force DF1 applied by the displacement actuator 23 disengages the lock mechanism 71 and then applies the required force to reconfigure the bonnet hinge 3 to the displaced configuration.

The mounting arrangement of the displacement actuator 23 may be modified. For example, the displacement actuator 23 may be disposed between the bonnet mounting bracket 31 and one of the following: the pivoting link 43, the control arm 37 and the vehicle body 5. In the embodiment illustrated in Figure 7, the displacement actuator 23 is disposed between the bonnet mounting bracket 31 and the body member 15. The gas generator 25 is mounted to the body member 15 and the displacement piston 27 is configured to act on the bonnet mounting bracket 31. It will be understood that the mounting arrangement of the displacement actuator 23 does not materially influence the operation of the bonnet hinge 3 according to the present invention.

It will be appreciated that various changes and modifications can be made to the present invention without departing from the scope of the present application.

The bonnet hinge 3 has been described herein with reference to a linkage assembly 35 for controlling movement of the bonnet 11. The linkage assembly 35 is configured such that the bonnet 11 undergoes a combination of rotation and translation as it is displaced between the bonnet rest, bonnet open and bonnet displaced configurations. It will be understood that the bonnet hinge 3 may be configured to provide different mechanisms for movement of the bonnet 11. The movement of the bonnet 11 from the closed configuration to the open configuration may comprise or consist of a pivoting motion or a translational motion. The pivoting motion of the bonnet 11 from the closed configuration to the open configuration may, for example, occur about a single pivot axis. The movement of the bonnet 11 from the closed configuration to the displaced configuration may comprise or consist of a pivoting motion or a translational motion. The pivoting motion of the bonnet 11 from the closed configuration to the displaced configuration may, for example, occur about a single pivot axis.

The bonnet 11 is rear mounted in the present embodiment (i.e. the bonnet hinge 3 is provided to mount a rear portion of the bonnet 11). It will be understood that the bonnet 11 could be front mounted. For example, the bonnet hinge 3 may be configured to support a front portion of the bonnet 11.

CLAIMS

1. A bonnet hinge for coupling a portion of a bonnet to a vehicle body, the bonnet hinge being configurable in a closed configuration for closing the bonnet over a storage compartment, an open
5 configuration for opening the bonnet to provide access to the storage compartment, and a displaced configuration for displacing the coupled portion of the bonnet from the vehicle body, the bonnet hinge comprising:

a pivotable coupling for connection to the vehicle body;

a hinge arm connected to the coupling;

10 a bonnet mounting bracket connected to the hinge arm and configured for fastening to the bonnet;
a control arm connected to the hinge arm and comprising an opening actuator attachment point for receiving an opening actuator to provide a normal operation force to reversibly move the bonnet hinge between the closed and open configurations;

15 a lock mechanism arranged to releasably maintain a geometric relationship between the bonnet mounting bracket, the control arm and the hinge arm; and

at least one displacement actuator attachment point for receiving a displacement actuator to provide a displacement force to move the bonnet hinge to the displaced configuration,

20 wherein the lock mechanism substantially maintains said geometric relationship during application of the normal operation force to pivot the coupling and transition between the closed and open configurations while preventing transition to the displaced configuration, and wherein on application of the displacement force the lock mechanism releases such that said geometric relationship is not maintained and the bonnet hinge transitions to the displaced configuration.

2. A bonnet hinge as claimed in claim 1, wherein the lock mechanism comprises: a first locking
25 member provided on the bonnet mounting bracket, and a second locking member provided on the control arm; wherein the first and second locking members cooperate with each other to releasably maintain said geometric relationship, and on application of the displacement force release from said cooperation to release said geometric relationship.

30 3. A bonnet hinge as claimed in claim 2, wherein the first locking member comprises one of a cam and a cam surface; and the second locking member comprises the other one of the cam and the cam surface.

35 4. A bonnet hinge as claimed in claim 1, wherein the lock mechanism comprises a locking link member pivotally connected at respective ends to the control arm and the bonnet mounting bracket, the locking link member being configurable in an over-centre position to releasably maintain said geometric relationship, wherein on application of the displacement force the locking link member passes the centre position to release said geometric relationship.

40 5. A bonnet hinge as claimed in any one of the preceding claims, wherein the control arm is pivotally connected to the hinge arm by a pivot pin defining a pivot axis;

wherein on application of the displacement force the control arm pivots relative to the hinge arm about the pivot axis.

6. A bonnet hinge as claimed in claim 5, wherein the hinge arm is pivotably connected to the bonnet mounting bracket and the bonnet mounting bracket comprises a guide aperture; the pivot pin extending into the guide aperture to limit pivoting movement of the hinge arm relative to the bonnet mounting bracket.

7. A bonnet hinge as claimed in claim 6, wherein said pivotable connection of the hinge arm and the bonnet mounting bracket is offset from said pivot axis.

8. A bonnet hinge as claimed in any one of the preceding claims, wherein the hinge arm is connected to the vehicle body by a linkage assembly having first and second said pivoting links, the second end of each of the first and second pivoting links being pivotally connected to the hinge arm.

9. A bonnet hinge as claimed in claim 8, wherein the first end of each of the first and second pivoting links is pivotably connected to a bracket fastenable to the vehicle body.

10. A bonnet hinge as claimed in any preceding claim wherein the at least one displacement actuator attachment point comprises a first displacement actuator attachment point arranged on the bonnet mounting bracket.

11. A bonnet hinge as claimed in claim 10 wherein the at least one displacement actuator attachment point comprises a second displacement actuator attachment point arranged on the control arm for receiving the displacement actuator so that the displacement actuator is positionable between the bonnet mounting bracket and the control arm.

12. A bonnet hinge as claimed in any preceding claim wherein, the bonnet hinge is retained in the displaced configuration after application of the displacement force.

13. A vehicle comprising a bonnet and a bonnet hinge as claimed in any one of the preceding claims.

14. A vehicle as claimed in claim 13 comprising at least one opening actuator operable to generate at least one normal operation force, the at least one opening actuator being connected at a first end to a body member of the vehicle and at a second end to the control arm.

15. A vehicle as claimed in claim 13 or claim 14 comprising at least one displacement actuator operable to generate the normal operation force to configure the bonnet hinge in the bonnet displaced configuration, thereby deploying the bonnet.

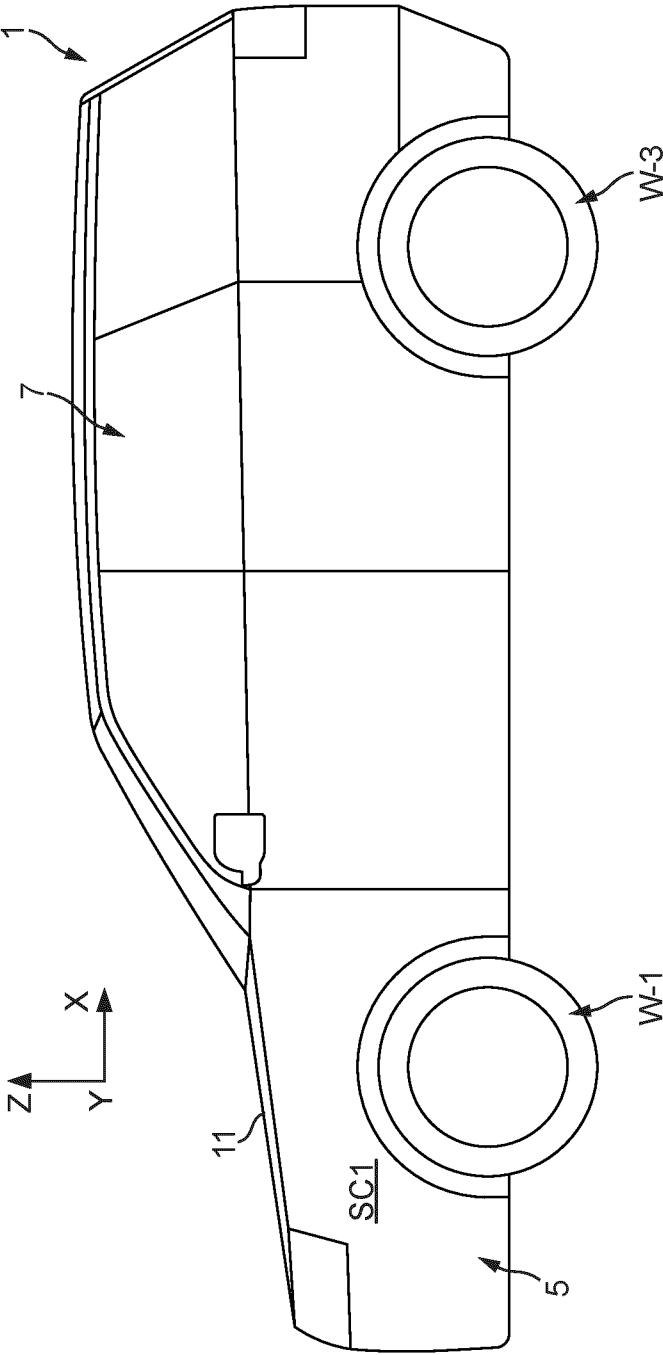


FIGURE 1

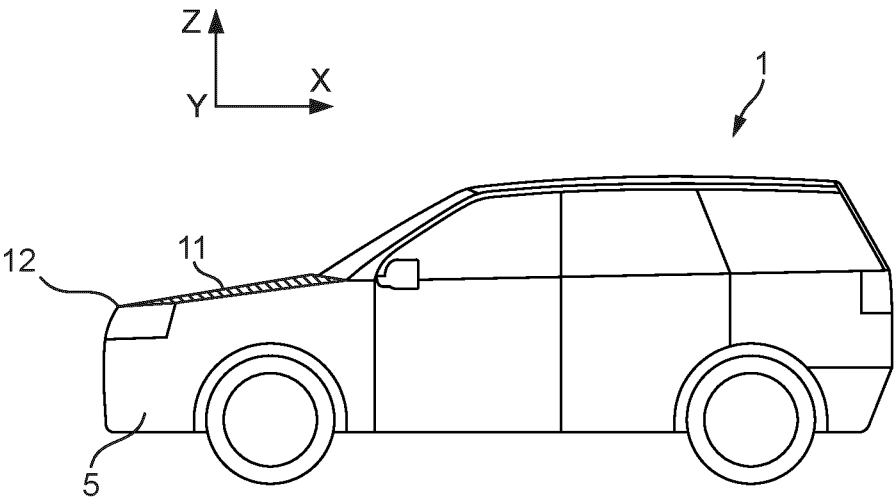


FIGURE 2A

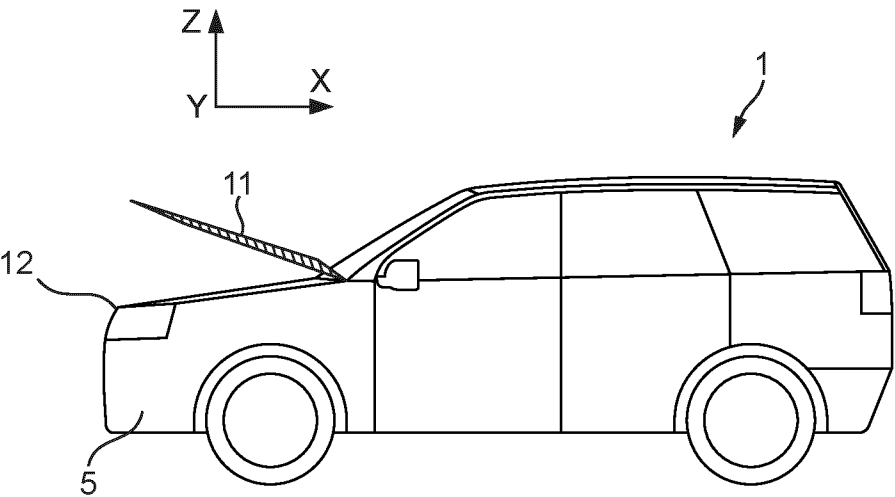


FIGURE 2B

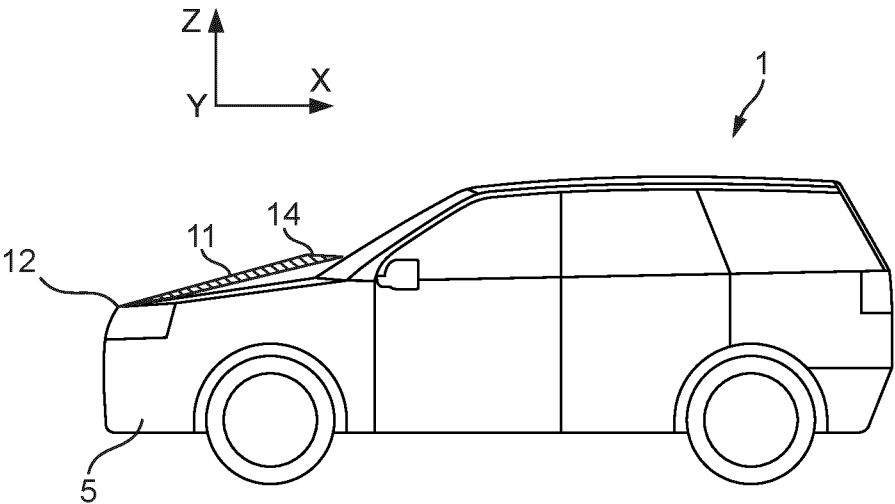


FIGURE 2C

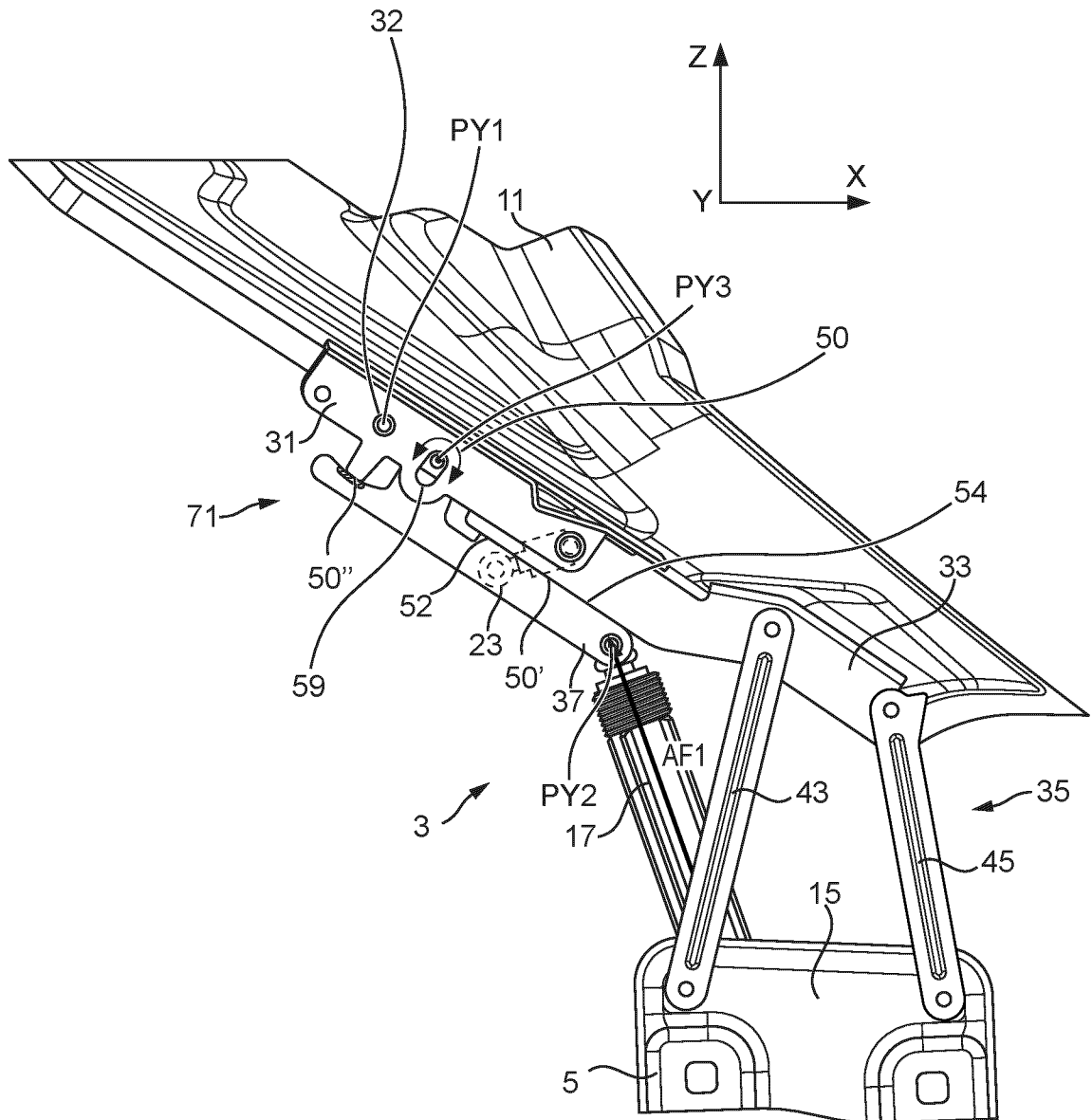


FIGURE 4

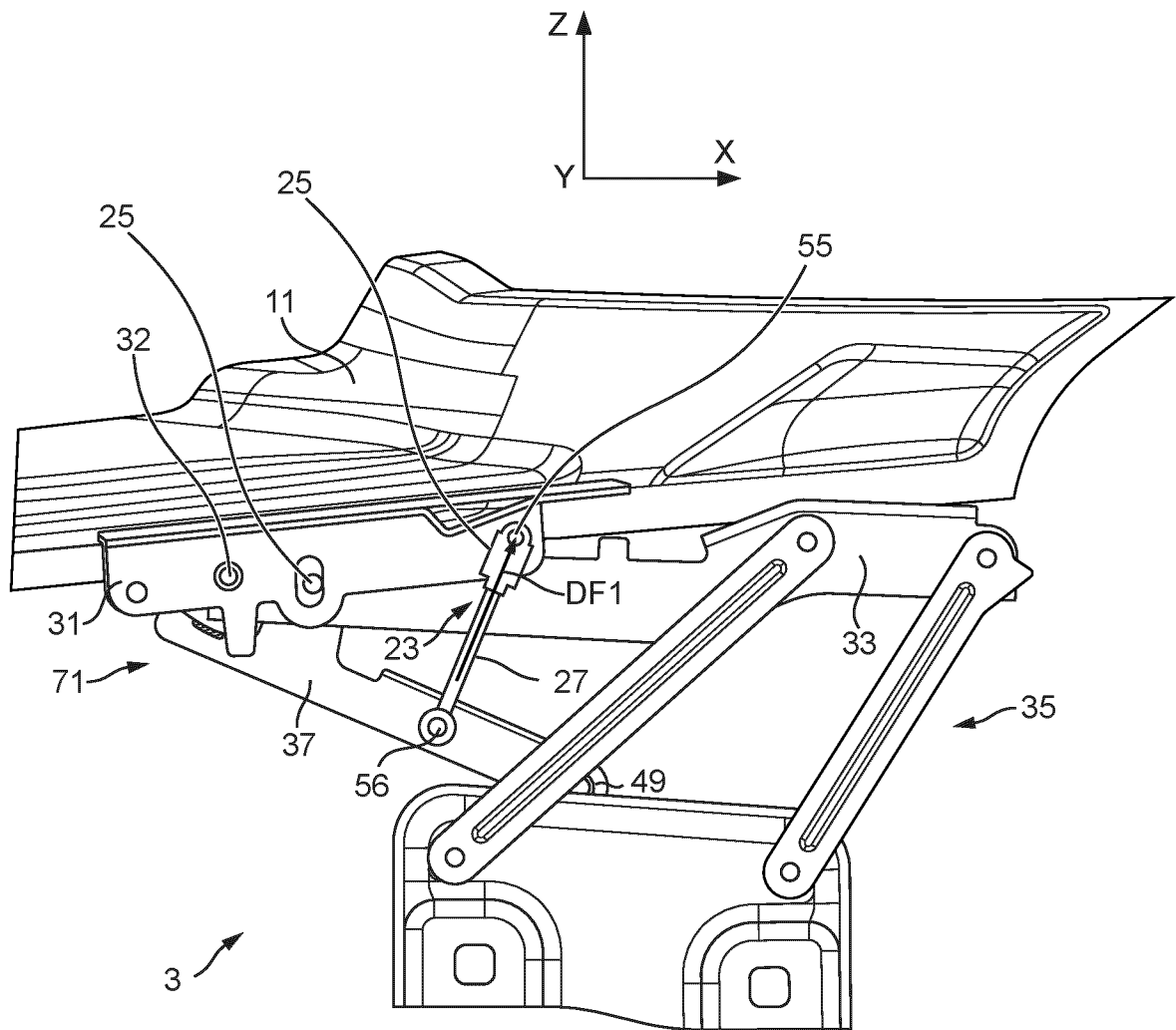


FIGURE 5

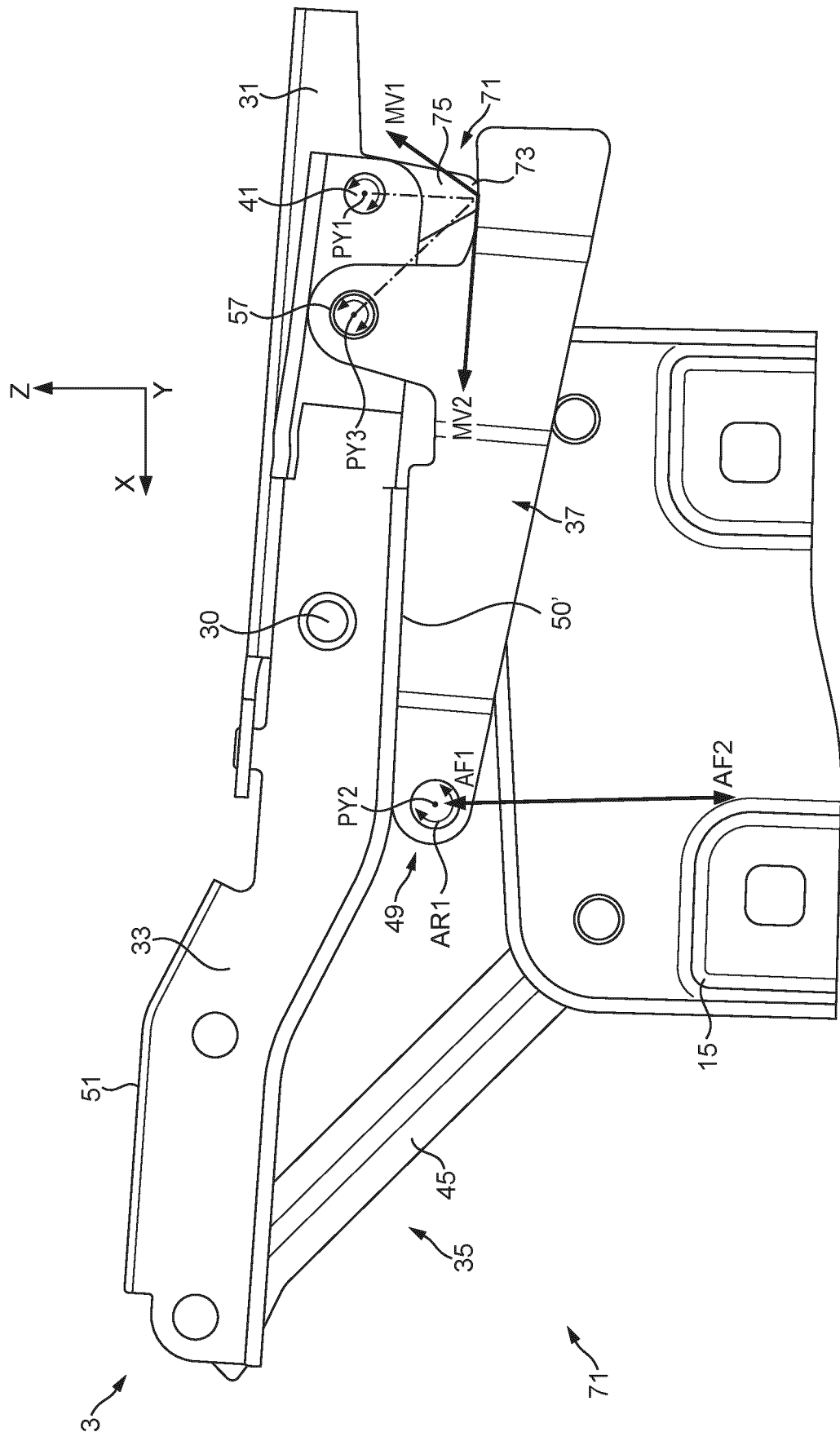


FIGURE 6

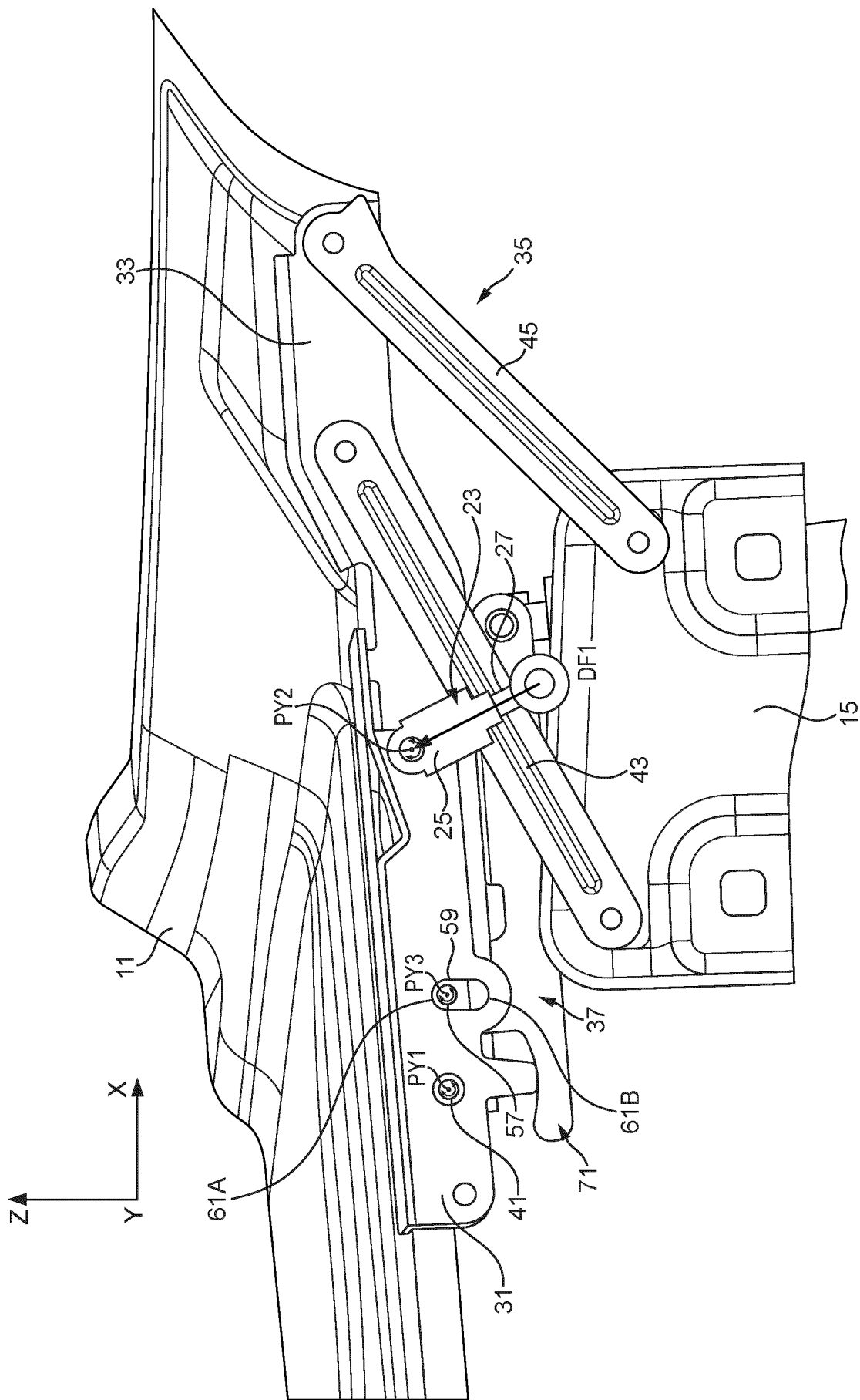


FIGURE 7

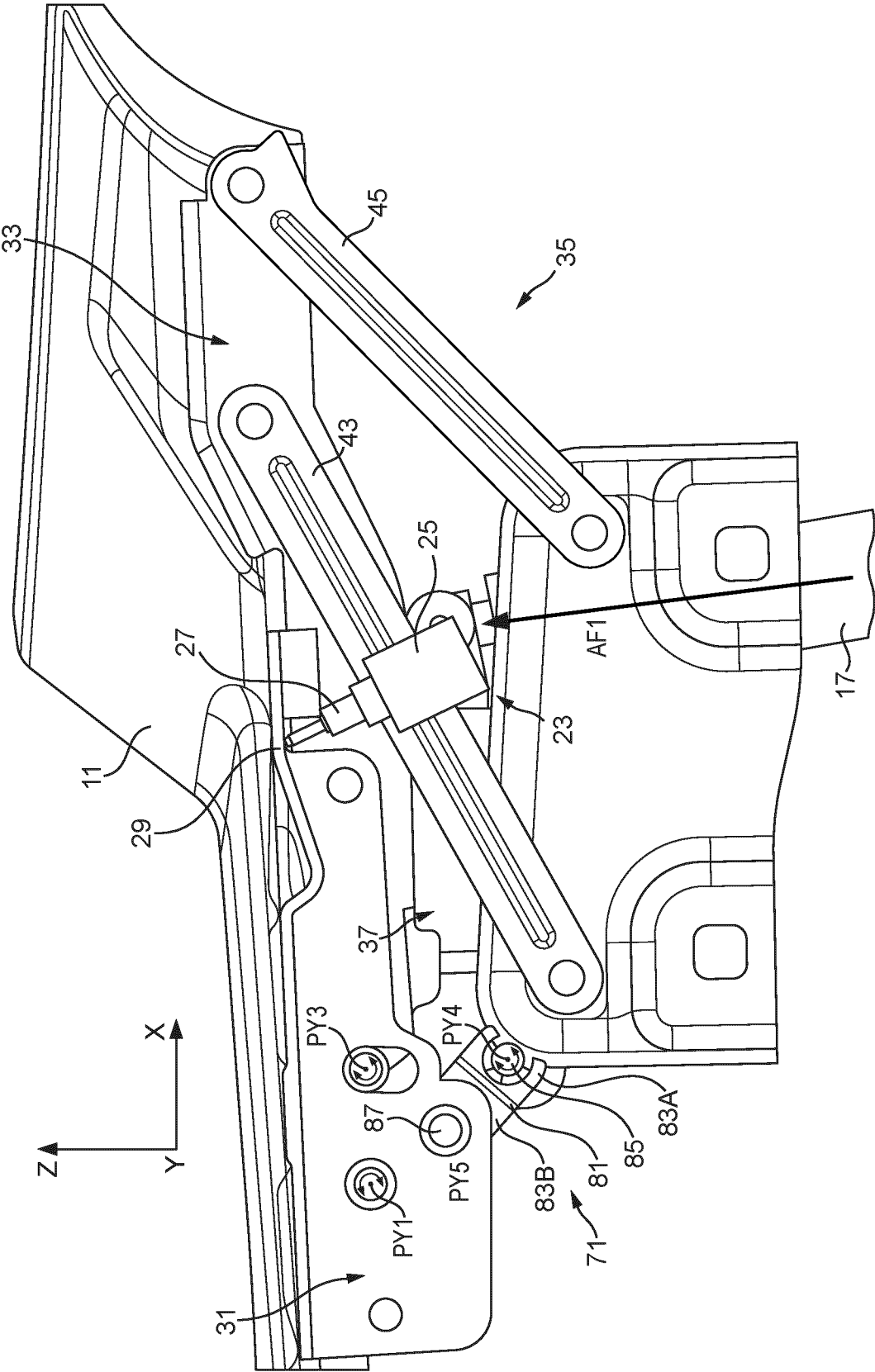


FIGURE 8

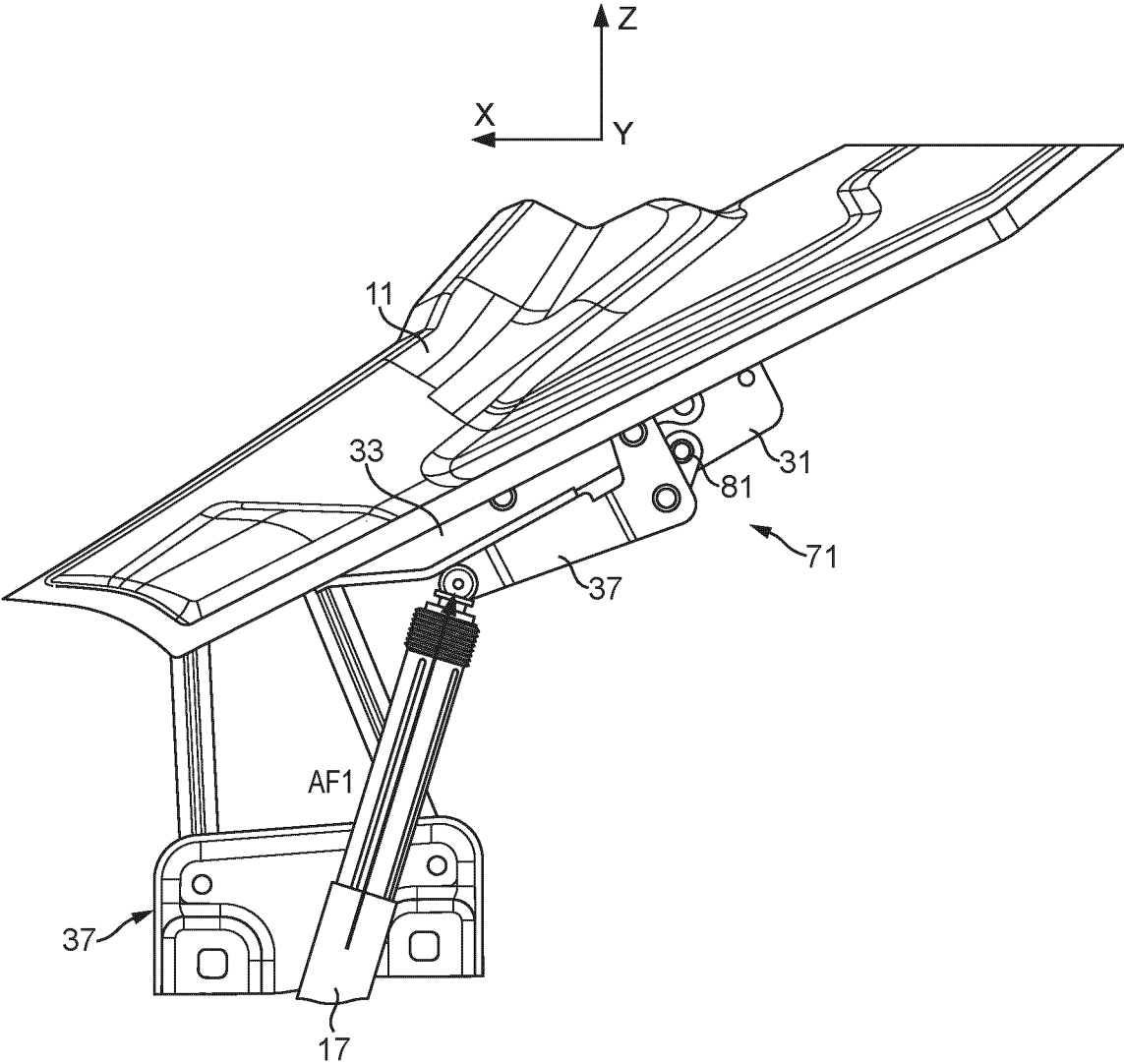


FIGURE 9

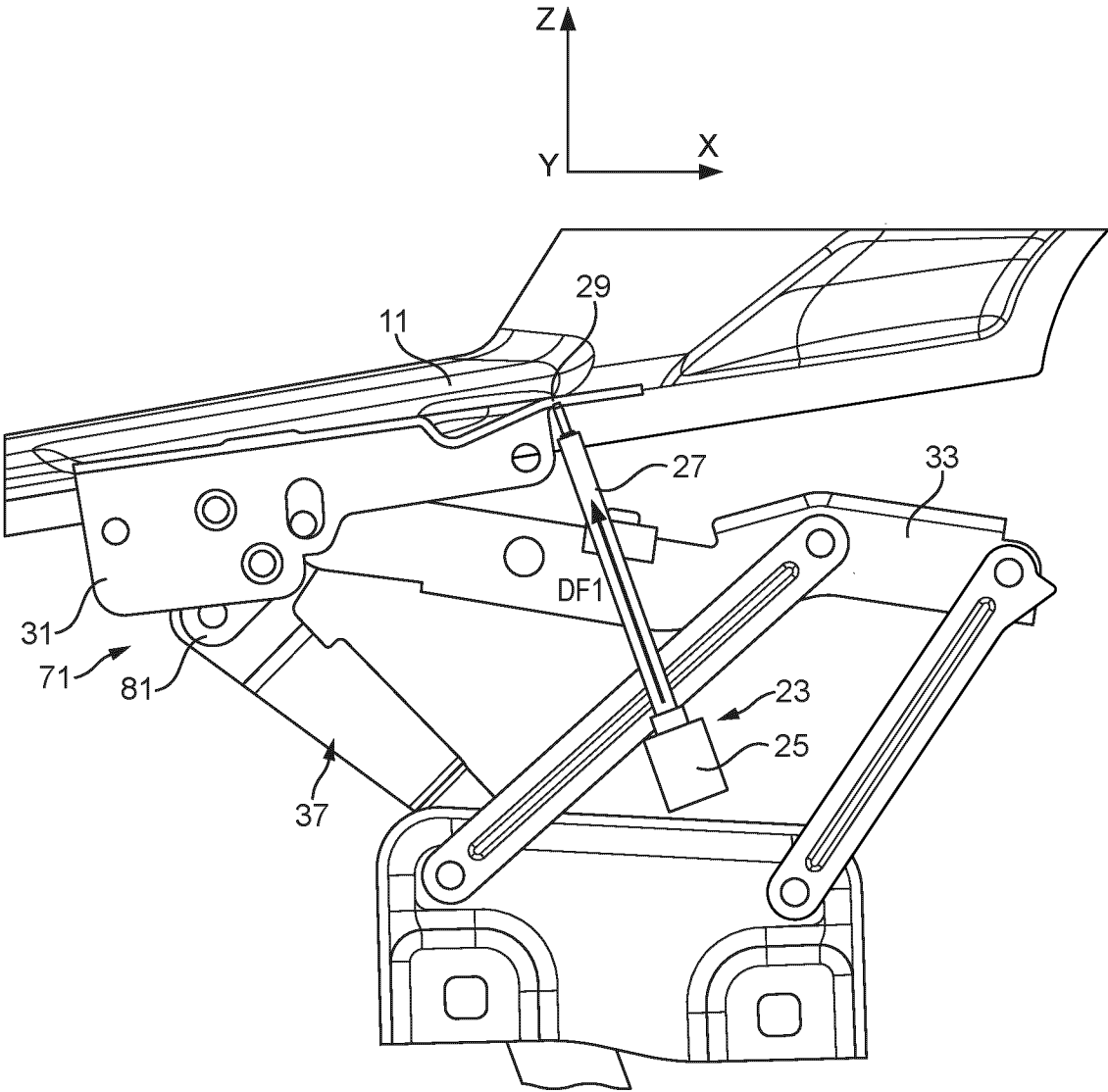


FIGURE 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/068506

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60R21/38

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.
A	DE 10 2022 121058 B3 (EDSCHA ENG GMBH [DE]) 17 May 2023 (2023-05-17) paragraphs [0032] - [0056]; figures 1-8 -----	1 - 15
A	EP 2 862 757 A1 (AUDI AG [DE]) 22 April 2015 (2015-04-22) paragraphs [0031], [0032]; figure 4 -----	1 - 15
A	DE 10 2013 017453 B4 (AUDI AG [DE]) 12 July 2018 (2018-07-12) paragraphs [0022] - [0030]; figures 1-3 -----	1 - 15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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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"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

10 October 2024

Date of mailing of the international search report

21/10/2024

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/068506

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