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(54) A mechanism for a door of a vehicle

(57) A selector mechanism is provided. The mechanism is associated with a swinging arm that attaches a door to a vehicle. The mechanism is configured for selectably coupling a vehicle door and a door pivot to operate the door either as a sliding door or as a hinged door. The mechanism comprises a latch for selectably latching the vehicle door to the swinging arm, the mechanism having a coupling, unlatched state and a decoupling, latched state. In the coupling, unlatched state, the latch partially releases the door from the arm so the mechanism couples the door pivot to the door so that pivoting of the door pivot, with respect to the arm, is transmitted to the door so that the door can operate as a sliding door. In the decoupling, latched state, the latch latches the door to the arm so the mechanism decouples the door pivot from the door so that pivoting of the door pivot, with respect to the arm, is not transmitted to the door when the door operates as a hinging door.

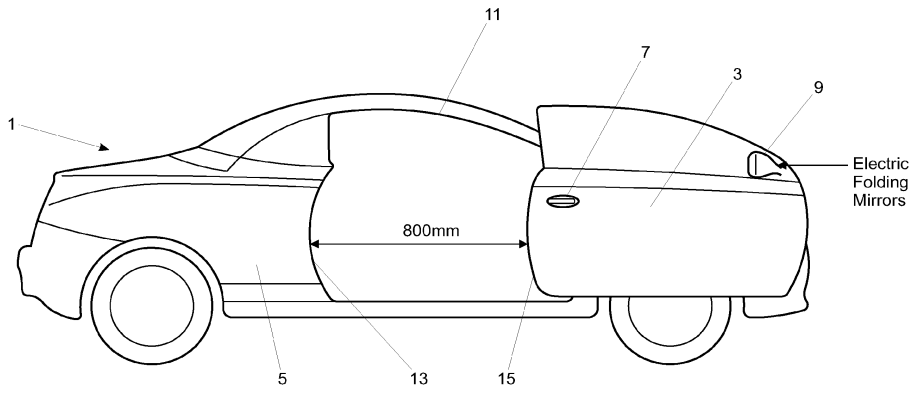


Fig.1

EP 1 867 827 A2

Description

[0001] The invention relates to a mechanism for selectably operating a door as a hinged door or as a sliding door, a door comprising the mechanism and applications of the door. The invention is particularly, but not exclusively, intended for use in motor vehicles and so encompasses a vehicle having the mechanism or door of the invention.

[0002] Vehicle doors are most commonly supported for pivoting movement by a hinge mechanism. Such mechanisms need few moving parts, and a door supported by a hinge mechanism is quickly and easily opened because it opens in one movement involving a push from within the vehicle or a pull from outside the vehicle. However, when a door fitted with a hinge mechanism is opened in a confined space it encounters a problem. If there is insufficient space to the side of the vehicle, the door cannot be opened sufficiently to allow access either into or out of the vehicle. There is also the risk of causing damage to the door, or to whatever is blocking the door, such as a neighbouring vehicle.

[0003] Sliding door mechanisms are known that overcome these problems. A vehicle door fitted with a sliding mechanism opens in two stages. Firstly the door moves out of a closed position in a door opening to an intermediate substantially parallel position adjacent the door opening so that the door is spaced away from the side of the vehicle. The door is then slid along the side of the vehicle into its open position. It is, thus, possible to open a sliding vehicle door in a confined space in which it would not be possible to use a hinged door.

[0004] A problem encountered in using sliding doors is that the speed and ease of ingress or exit is limited because the sliding door has to be opened in at least two movements, not just one like a hinged door.

[0005] So, a vehicle fitted with hinged doors is easy to enter and exit except in a confined space when the door may not be fully opened. A vehicle fitted with sliding doors can be entered and exited in a confined space, but in all other circumstances the user must tolerate their inconvenience of operation.

[0006] The invention resides in a door arrangement that is selectably hinging and sliding.

[0007] From the prior art it is known for doors to have two modes of operation: a sliding mode and a hinging mode; and for sliding doors to have hinging mechanisms. Those doors with two modes of operation have a means of selecting the mode of operation that is crude and ineffective, that may cause the incorrect selection of the mode of operation of the door.

[0008] Sliding doors with hinge characteristics are incapable of being opened as hinged doors. As described above they open in two movements, the hinging aspect of motion being inherent in the movement from the closed position to the intermediate parallel position. Thus, the hinging motion required in the opening of these sliding doors is in the sense demanded by the invention.

[0009] According to the present invention there is provided a selector mechanism for selectably coupling a vehicle door and a door pivot to operate the door either as a sliding door or as a hinged door. The mechanism has a coupling state and a decoupling state. In the coupling state, the mechanism couples the door pivot to the door so that pivoting of the door pivot is transmitted to the door so that the door can operate as a sliding door. In the decoupling state, the mechanism decouples the door pivot from the door so that pivoting of the door pivot is not transmitted to the door when the door operates as a hinging door.

[0010] The mechanism may further comprise a coupling operable to engage the door pivot to the door in the coupling state so as to transmit pivoting drive between the door pivot and the door, and to disengage the door pivot from the door in the decoupling state when pivoting drive is not to be transmitted.

[0011] In the coupling state the coupling may be engaged by inter-engagement of a complementary recess and protrusion.

[0012] The recess and the protrusion may each be shaped to have at least one flat so that when the recess and protrusion are engaged, pivoting drive may be positively transmitted therebetween.

[0013] The mechanism may further comprise a door connector for engaging with the door and the coupling may be associated with the door connector. The mechanism may further comprise a pivot connector for engaging with the door pivot and the coupling may be associated with the pivot connector. The mechanism may be pivotable about a rotational axis of the door pivot. At least part of the mechanism may be configured to move substantially parallel to the rotational axis to couple the door pivot to the door and to decouple the door pivot from the door.

[0014] A spindle may lie on the rotational axis and the mechanism may include a female part co-operable with the spindle for coupling.

[0015] The mechanism may be associated with a swinging arm that attaches the door to a vehicle, for hinging or sliding movement of the door.

[0016] Furthermore, according to the present invention there is provided a selector mechanism for selectably coupling a vehicle body and a body pivot. The body pivot is connected to a vehicle door by a swinging arm via a door pivot. By selectably coupling the vehicle body and the body pivot, the door operates either as a sliding door or as a hinged door. The mechanism has a coupling state and a decoupling state. In the coupling state, the mechanism couples the body pivot to the body so that pivoting of the arm about the body pivot is transmitted to drive the door to pivot about the door pivot so that the door can operate as a sliding door. In the decoupling state, the mechanism decouples the body pivot from the body so that when the door operates as a hinging door, pivoting of the arm about the body pivot is not transmitted to the door pivot.

[0017] The mechanism may comprise a coupling operable to engage the body pivot to the body in the coupling state so as to transmit pivoting drive to the door pivot, and may disengage the body pivot from the body in the decoupling state when pivoting drive is not transmitted to the door pivot. In the coupling state the coupling may be engaged by inter-engagement of a complementary recess and protrusion. The recess and the protrusion may each be shaped to have at least one flat so that when the recess and protrusion are engaged, pivoting drive may be positively transmitted therebetween.

[0018] The mechanism may further comprise a body connector for engaging with the body. The coupling may be associated with the body connector. The mechanism may further comprise a pivot connector for engaging with the body pivot and the coupling may be associates with the pivot connector. The mechanism may be pivotable about a rotational axis of the body pivot. At least part of the mechanism may be configured to move substantially parallel to the rotational axis to couple the body pivot to the body and to decouple the body pivot from the body.

[0019] A spindle may lie on the rotational axis and the mechanism may include a female part co-operable with the spindle for coupling.

[0020] The mechanism may further comprise a latch for selectably latching the vehicle door to the swinging arm that attaches the door to a vehicle for hinging or sliding movement of the door, the latch having a latched state and an unlatched state,
wherein:

a) in the latched state, the latch latches the door to the arm to restrain movement of the door with respect to the arm when the door operates as a hinged door, swinging with the arm; and

b) in the unlatched state, the latch partially releases the door from the arm so that the door can pivot with respect to the arm when the door is to operate as a sliding door.

[0021] In the latched state, the latch may be configured to latch the door to the arm by inter-engagement of a complementary recess and protrusion.

[0022] The latch may be extendable so that in the latched state, the protrusion is extended into engagement with the recess and in the unlatched state, the latch is retracted out of engagement from the recess.

[0023] The mechanism may further comprise an actuator to change the state of the mechanism between the coupling and decoupling states. The actuator may be operated in the decoupling state so as to permit the mechanism to change into the coupling state. A resilient biasing means may be configured to move the mechanism into the coupling state when the actuator is operated in the decoupling state. The actuator may be configured to operate to change the mechanism between the coupling and decoupling states in response to a control signal. The signal may transmitted to the mechanism by a transmitting force, or via a cable.

[0024] Furthermore, according to the present invention there is provided a mechanism for selectably operating a door as a sliding door or as a hinged door with respect to a body such as a vehicle fitted with such a door, the mechanism comprising:

an arm having a door pivot that is pivotally movable with respect to the arm to cause pivotal movement of an attached door with respect to the arm, and a body pivot spaced from the door pivot for pivotal attachment of the arm to the body whereby the arm is pivotable with respect to the body upon opening or closing the door;

a selector for selecting between sliding and hinging modes of operation; and

a door pivot drive acting upon the door pivot under the control of the selector;

wherein, in the sliding mode, the door pivot drive drives relative pivotal movement between the door pivot and the arm, this in turn causing relative pivotal movement of the door with respect to the arm when the door is moved from a closed position by the arm upon opening to position the door for sliding movement with respect to the body, and conversely upon closing, and the door pivot drive acts upon the door pivot in response to the relative pivotal movement between the arm and the body; and
in the hinging mode, upon opening, and upon closing, the door is caused to pivot relative to the body without sliding.

[0025] When in the sliding mode as determined via the selector, relative pivotal movement between the arm and the body pivot may be effected by pivoting the arm with respect to the body upon opening or closing the door; the door pivot drive may be responsive to the relative pivotal movement between the arm and the body pivot to act upon the door pivot under the control of the selector; and in the sliding mode, the door pivot drive may be configured to respond to relative pivotal movement between the arm and the body pivot to drive the relative pivotal movement between the door pivot and the arm that causes relative pivotal movement of the door with respect to the arm.

[0026] The door pivot drive may be configured to transmit to the door pivot relative pivoting movement of the body pivot with respect to the arm. The selector may be configured to interrupt said transmission when in the hinging mode. The selector may also include a clutch in the door pivot drive. The selector may act on the door pivot and the door pivot drive may comprise a gear train between the body pivot and the door pivot. The door pivot drive may further comprise a linkage between the body pivot and the door pivot. The arm may include at least one bend and the door pivot drive transmits drive along

the arm and around said bend. The door pivot drive may be configured not to drive relative pivotal movement between the door pivot and the arm.

[0027] In the hinging mode, the door may be attached to the arm to arrest pivoting movement of the door with respect to the arm as the door and the arm pivot with respect to the body.

[0028] In the sliding mode, when the door is moved from its closed position by the arm upon opening, the door may be configured to be moved outwardly from the body to position it for sliding movement with respect to the body.

[0029] In the sliding mode, when the door is moved by the arm from its closed position to position the door for sliding movement with respect to the body, the door may be restricted relative to the arm to prevent sliding motion of the door with respect to the body.

[0030] Furthermore, according to the present invention there is provided a selector handle for selecting between sliding and hinging modes of operation of a vehicle door attached to a vehicle body, the handle comprising a control element operable to release the door for opening movement, wherein the control element is movable between a sliding position in which the control element is operable to open the door by sliding and a hinging position in which the control element is operable to open the door by hinging.

[0031] The operation of the control element to open the door may be configured to unlatch the door to be pushed or pulled open. The control element may be operable by pivoting about a substantially horizontal axis to open the door by sliding. The control element may operable by pivoting about a substantially vertical axis to open the door by hinging.

[0032] In the sliding position, the control element may be configured to lie generally vertically. In the hinging position, the control element may be configured to lie generally horizontally.

[0033] The control element may be pivotable between the sliding and hinging positions. The movement of the control element between the sliding and hinging positions may be configured to transmit a control signal for controlling a hinging/sliding selector mechanism associated with the door.

[0034] The signal may be transmitted by transmitting a force to the selector mechanism, preferably via a cable.

[0035] The handle may be part of a side mirror attached to the door.

[0036] The control element may have an engaged position in which the door is secured to a sliding mechanism during sliding movement as the door is slid alongside the vehicle body.

[0037] The handle may be applied to a door. The door may further comprise a location for applying pressure to the door when the door operates as a sliding door so as to move the door from the closed position into position for sliding movement with respect to the body. The location may be in a forward lower portion of the door.

[0038] The door may further comprise a location for pulling the door when the door operates as a sliding door so as to move the door from the closed position into position for sliding movement with respect to the body. The pulling location may be in a forward upper portion of the door and/or it may be defined by a side mirror.

[0039] The present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a vehicle, such as a car, fitted with a mechanism according to the present invention, showing the vehicle with an open door when the mechanism is in its sliding mode;

Figure 2 is a schematic, perspective view of an interior of the door of the vehicle shown in Figure 1, having a selector handle for selecting the mode of operation of the mechanism;

Figure 3 is a schematic cross-sectional plan view through a side of the vehicle shown in Figure 1 illustrating the vehicle door and part of the associated vehicle body, showing the relative positions of the door, the body and the location of a mechanism embodying the invention, in a closed position, in an open position when in a hinging mode, and in a open position when in a sliding mode;

Figures 4a and 4b are schematic cross-sectional plan views of the door, and a side part of the body, as shown in Figure 3 when the door is in a closed position and when the door is open in a hinging mode respectively;

Figure 5a, 5b and 5c are schematic cross-sectional plan views of the door, and a side part of the body, as shown in Figure 3 when the door is in a closed position, whilst the door is in transition between the closed position and an intermediate position parallel to the side of the vehicle body when in a sliding mode, and when the door is in the intermediate position, respectively;

Figures 6a, 6b and 6c are schematic cross-sectional plan views of the door, and a side part of the body shown in Figure 3, in a sliding mode, when the door is in an intermediate position, in transition to an open position, and in the open position, respectively;

Figure 7 is plan view of an 'S' shaped arm having a mechanism embodying the invention, with a plate removed to show the components of the mechanism;

Figure 8 is a side perspective view of the arm shown in Figure 7, also with a plate removed to show the components of the mechanism;

Figure 9 is an end perspective view of the arm shown in Figures 7 and 8, similarly with a plate removed to show the internal components of the mechanism;

Figure 10 is an exploded perspective side view of the arm shown in Figure 7, showing the components that comprise the mechanism;

Figure 11 is an exploded side view of the arm shown in Figure 7, viewed side on, and showing the components that comprise a body gear train and a door gear train of the mechanism;

Figure 12 is a plan view of the arm shown in Figure 7, with a plate removed, showing the relative positions of features of the mechanism;

Figure 13 is an end perspective view of the mechanism shown in Figure 9, indicating certain features of the mechanism;

Figure 14 corresponds to Figure 12, but indicates certain operational features of the gearing of the mechanism, and the relative directions of pivoting and movement of features of the mechanism, on opening of an attached door;

Figure 15 is a plan view of the mechanism shown in Figure 14, showing the relative positions, and directions of pivoting and movement of features of the mechanism when in the open and the closed positions of the mechanism;

Figure 16 is a plan view of a mechanism shown in Figure 15 attached to a vehicle door when in a hinging mode;

Figure 17 is a plan view of a mechanism shown in Figure 15 attached to a vehicle door when in a sliding mode;

Figure 18 is a perspective view of a slide that is fitted to a vehicle door;

Figures 19a, 19b and 19c are schematic perspective views of a vehicle door fitted with the mechanism of Figure 7 at three stages of operation in a sliding mode;

Figures 20a, 20b and 20c are schematic perspective views of a vehicle door fitted with the mechanism of Figure 7 at three stages of operation in a hinging mode;

Figure 21 is a schematic cross-sectional view of a vehicle door and part of the vehicle as shown in Figure 1, with the 'S' shaped embodiment of the invention shown in Figure 7;

Figure 22 is a detailed schematic perspective view of the vehicle door as shown in Figure 19a;

Figure 23 is a schematic perspective view of an upper arm and a lower arm that are present in Figure 22 connecting the door to the body of the vehicle;

Figure 24 is a further schematic perspective view of the upper and lower arms present in Figure 22;

Figure 25 is a further schematic perspective view of the upper and lower arms present in Figure 22;

Figures 26a and 26b are schematic perspective views of a collar that is present in Figure 25;

Figure 27 is a schematic perspective view of the upper arm present in any of Figures 22 to 25 with the collar of Figures 26a and 26b;

Figure 28 is a schematic perspective view of the upper arm shown in Figures 27, and the collar illustrated in Figures 26a and 26b;

Figure 29a and 29b are perspective views of components of a selecting mechanism as shown in Figure 28, including the collar illustrated in Figures 26a and 26b, and a locking pin;

Figure 30 is a perspective view of an upper plate of the arm shown in Figure 27;

Figure 31 is a schematic perspective view of the upper arm shown in Figure 27 showing the features of the selecting mechanism that operates the collar shown in Figures 26a and 26b;

Figure 32 is a further schematic perspective view of the upper arm and the collar, as shown in Figure 28;

Figure 33 is a schematic perspective view of the upper arm shown in Figure 27 showing the features of a selector mechanism that operates the locking pin shown in Figure 29b;

Figure 34 is a detailed perspective view of the selector handle shown in Figure 2;

Figure 35 is a schematic perspective view of an interior of the vehicle door as shown in Figure 2;

Figure 36 is an external perspective view of the vehicle door shown in Figure 2, illustrating an external selection handle on a side mirror of the vehicle;

Figure 37 is a perspective view of the side mirror shown in Figure 36, the external selection handle being in a closed position; and

Figure 38 is a perspective view of the side mirror shown in Figure 36, the external selection handle being in an open position.

Detailed Description

[0040] Referring to Figure 1, a vehicle 1 here exemplified as a car has a selectably sliding and hinging door 3. The door 3 in Figure 1 is shown as a forward-sliding door when it is fully open in a slid open position. In a closed position the door 3 is secured to a body 5 of the vehicle 1 to prevent ingress to and egress from the interior of the vehicle 1. When the door 3 is operable as a hinged door, the door 3 pivots away from the closed position and the body 5. As a sliding door, the door 3 moves out of the closed position into a position as shown in which the door 3 can be slid relative to the body 5 to permit ingress to and egress from the interior of the vehicle 1.

[0041] The door 3 has an external handle 7 for operating the door 3 to open and close, as well as to move the door 3 between its open and closed positions when it operates as a hinged door. A side mirror 9 is located toward a forward edge 8 of the door. In the slid open position the mirror 9 is foldable towards the door 3, as shown. The mirror 9 folds towards the door 3 as the door 3 is moved from its closed position to the slid open position. Thus, it is possible to open the door 3 in a confined space, reducing the risk of damage to the mirror 9.

[0042] In one instance, the maximum clearance of the opening between a rearward edge 13 of the door aperture 11 and a rearward edge 15 of the door 3 to access and to exit from, the interior of the vehicle 1 is about 800 mm.

[0043] Referring to Figure 2, the interior of a left side door 3 is shown with a selector handle 14 for selecting operation of the door as a hinged door or as a sliding door. The selector handle 14 is pivotable between two positions, in the directions shown by arrows 12. In one position, the door 3 operates as a hinged door, in the other position the door 3 operates as a sliding door. The selector handle 14 operates as an internal handle that can be used to open the door 3 when the door 3 operates as a hinged door, but not when the door 3 operates as a sliding door.

[0044] Referring to Figure 3, part of the body 5 is shown to comprise the door aperture 11 within which is located the door 3 in the closed position A. Figure 3 also shows the position of the door 3 when it is in the hinging open position B when the door 3 operates as a hinged door, and in the slid open position C when the door 3 operates as a sliding door. Connecting the door 3 and the body 5 is a mechanism 16 comprising a door pivot 19, a body pivot 21 and an arm 17 that is attached at one of its ends to the door 3 at the door pivot 19, and at the other end of its ends to the body 5 at the body pivot 21. In this figure, the position of the arm 17 is shown when the door 3 is in the hinging open position A and the slid open position C. Note that the clearance of the door 3 from the body 5 in the slid open position C is less than the clearance of the door 3 from the body 5 in the hinging open position B. This allows the door 3 to be opened in confined spaces in which hinging open would not allow access to or egress from the interior of the vehicle 1.

[0045] Referring to Figure 4a, the door 3 is shown in the closed position A and, referring to Figure 4b, the door 3 is shown in the hinging open position B. When the door 3 operates as a hinged door, the door 3 is locked relative to the arm 17, so that the door 3 cannot pivot relative to the arm 17 about the door pivot 19. So, the door 3 and the arm 17 pivot relative to the body 5 about the body pivot 21. On opening the door 3 to the hinging open position B, the door hinges about the body pivot 21. In one embodiment, when the door 3 is in the hinging open position B, the maximum clearance provided between the door aperture 11 and the door 3 is 400 mm.

[0046] Referring to Figures 5a, 5b and 5c, the door 3 is shown to be operating as a sliding door. In Figure 5a, the door is in the closed position A; in Figure 5b, the door is in transition from the closed position A to an intermediate position D; and in Figure 5c, the door is in the intermediate position D.

[0047] When the door 3 operates as a sliding door in transition between the closed position A and the intermediate position D, the door 3 is not locked relative to the arm 17. So, the arm 17 is pivotable relative to the body 5 about the body pivot 21, and the door 3 is pivotable relative to the arm 17 about the door pivot 19. However, during these relative pivotal movements, the door 3 is restricted relative to the arm 17 to prevent sliding motion. The movement of the door 3 with respect to the arm 17 during transition between the closed position A and the intermediate position D is achieved by a transmission of pivoting drive of the arm 17 relative to the body pivot 21 to drive the door pivot 19 so that the door 3 pivots relative to the arm 17. The door 3 therefore moves relative to the arm 17 in response to the movement of the arm 17 relative to the body 5.

[0048] Once the door 3 has moved into the intermediate position D, as shown in Figure 5c, it is substantially parallel to the body 5. The door pivot 19 is then constrained so that the door 3 does not pivot relative to the arm 17, and the arm 17 is constrained so that it does not pivot relative to the body 5: the door 3 is then permitted to slide relative to the arm 17.

[0049] Referring to Figures 6a, 6b and 6c, the door 3 is in the intermediate position D as shown in Figure 6a, in transition between the intermediate position D and the slid open position C as illustrated in Figure 6b, and in the slid open position C as shown in Figure 6c. In this series of three figures, the door 3 is slid relative to the arm 17 from the intermediate position D to the slid open position C. During this transition from the intermediate position D to the slid open position C, the door 3 moves substantially parallel to the side of the body 5.

[0050] Transmission of pivoting drive between the door pivot 19 and the body pivot 21 is achieved by a pivot drive 23 shown in Figure 7 that allows pivotal movement

of the arm 17 around the body pivot 21 to drive pivotal movement of the door pivot 19 relative to the arm 17 in the opposite direction, but at the same speed, so that pivoting of the door pivot 19 with respect to the arm 17 is synchronised with the pivoting of the arm 17 with respect to the body pivot 21. The pivot drive 23 may be selectably operated so that drive transmission between the door pivot 19 and the body pivot 21 may be interrupted.

[0051] When pivoting drive is transmitted between the body pivot 19 and the door pivot 21, the pivot drive 23 is in a sliding mode of operation, and a door 3 fitted with the pivot drive 23 operates as a sliding door. In this mode, the pivot drive 23 transmits pivoting drive of the body pivot 21 relative to the arm 17 to pivot the door pivot 19 relative to the arm 17. When pivoting drive is not transmitted between the two pivots 19, 21, the pivot drive 23 is in a hinging mode of operation and a door 3 fitted with the pivot drive 23 operates as a hinged door. A selector handle 14 as shown in Figure 2 is, thus, used to operably select between the two modes of operation of the pivot drive 23 when the door 3 is in the closed position A.

[0052] The arm 17 is 'S' shaped and the pivot drive 23 is located between a lower plate 25 and an upper plate 27 (not shown in Figure 7), each plate 25, 27 having two bends that curve in opposite directions to define the 'S' shape. The plates 25, 27 are secured together by a plurality of inter-plate pins 29 that provide sufficient clearance between the plates 25, 27 to accommodate the components of the pivot drive 23.

[0053] The pivot drive 23 transmits pivoting drive along the arm 17 around its two bends. To transmit drive, the pivot drive 23 comprises a body side gear train 31 that is connected to a drive linkage 33. The drive linkage 33 is in turn connected to a door side gear train 35. The gear trains 31, 35 extend along opposite ends 37 of the 'S' shaped arm 17. The drive linkage 33 interconnects the gear trains 31, 35 along an intermediate portion 39 of the arm 17, between the two bends. The body side gear train 31 is engaged with the body pivot 21, and the door side gear train 35 is engaged with the door pivot 19. Thus, pivoting of the body pivot 21 (in practice, relative pivotal movement of the arm 17 around the body pivot 21) is transmitted by the body side gear train 31 to the drive linkage 33 as translational drive. The drive linkage 33 in turn transmits the translational drive to the door side gear train 35 as pivoting drive, in order to pivot the door pivot 19.

[0054] The various components of the gear trains 31, 35 of the pivot drive 23 can be seen more clearly in Figures 8 and 9. The body side gear train 31 has three engaged components: an outer body gear 41, a middle body gear 43 and an inner body gear 45. The body gears 41, 43, 45 are positioned in a straight line along one end 37 of the arm 17. The outer body gear 41 is positioned outwards of the body gear train 31 towards the end 37 of the arm 17, the inner body gear 45 is located inwards of the body gear train 31, towards the door gear train 35 and the middle gear 43 is positioned between the inner and the outer body gears 41, 45. Each of the body gears 41, 43, 45 is toothed, and has an axis of rotation defined by a respective spindle 47 mounted to the plates 25, 27. Towards one end of each spindle 47 is a bearing 49, which permits the body gears 41, 43, 45 to freely pivot around the respective rotational axis. Note that the outer body gear 41 has a body pivot spindle 47a that is longer than the spindles 47 of the middle and inner body gears 43, 45. The extra length of the body pivot spindle 47a defines the body pivot 21 and is for attachment of the arm 17 to the body 5.

[0055] The door side gear train 35 also has three engaged toothed gears: an outer door gear 51, a middle door gear 53 and an inner door gear 55. The door gears 51, 53, 55 are positioned in a straight line along an opposite end 37a of the arm 17 from the body side gear train 31. The outer door gear 51 is positioned outwards of the door gear train 35 towards the end 37a of the arm 17, the inner door gear 55 is located inwards of the door gear train 35 towards the body gear train 31 and the middle door gear train 53 is positioned between the inner and the outer door gears 51, 55. Each door gear 51, 53, 55 is held in place between the plates 25, 27 by a spindle 47 which is connected to the upper plate 27 by a bearing 49. The outer door gear 51 has a door pivot spindle 47b, the extra length of which defines the door pivot 19 and is for engagement of the arm 17 to the door 3.

[0056] The drive linkage 33 connects the inner body gear 45 to the inner door gear 55. The drive linkage 33 includes a body crank 57 connected to the spindle 47 of the inner body gear 45, and a door crank 59 connected to the spindle 47 of the inner door gear 55. A push-pull rod 61 is pivotally connected at its ends to each of the two cranks 57, 59. Crank pins 60 pivotally secure the push-pull rod 61 to each of the cranks 57, 59. The cranks 57, 59 are of similar length and are similarly angularly positioned with respect to each other. Thus an angular displacement of the inner body gear 45 is transmitted via a translational movement of the push-pull rod 61 to displace the inner door gear 55 angularly through substantially the same angular displacement, and vice-versa.

[0057] Referring to Figure 10, the components of the arm 17 are shown in an exploded perspective view. The features of this figure common to previously described figures take the same reference numbers. Figure 10 additionally includes rivets 63 to secure each of the pins 29 to the plates 25, 27, and a washer 65 in between each of the gears 41, 43, 45, 51, 53, 55 and the lower plate 25.

[0058] Figure 11 is an exploded view of the arm 23 from side on. Features of this figure that are common to other figures previously described take the same reference numbers. This figure shows the plates 25, 27, the components of the door side gear train 35 and the body side gear train 31.

[0059] Referring to Figure 12, a plan view of the arm 17 is shown, with the upper plate 27 removed to reveal the features of the pivot drive 23. Features of this figure

that are common to previously described figures take the same reference numbers.

[0060] In Figure 13 the body pivot spindle 47a of the outer body gear 41 is secured to the body 5 and the outer body gear 41 is fixed to the body pivot spindle 47a, and thus to the body 5. So on pivoting the arm 17 relative to the body pivot 21 (and the body 5 to which the body pivot 21 is attached) the outer body gear 41 remains stationary with respect to the body 5, and the arm 17 pivots about the body pivot spindle 47a.

[0061] In the sliding mode the door pivot spindle 47b is engaged to the door 3 whilst the door 3 is in transition between the closed position A and the intermediate position D. The outer door gear 51 is fixed to the door pivot spindle 47b, so that on pivoting the outer door gear 51 with respect to the arm 17, the door pivot spindle 47b pivots to transmit drive to the door 3, causing the door 3 to move between the closed position A and the intermediate position D.

[0062] In transition between the intermediate position D and the slid open position C, the door 3 is free to slide relative to the arm 17 and the door pivot spindle 47b. However, the door 3 is secured to the arm 17 to arrest pivoting movement of the door 3 with respect to the arm 17. As the arm 17 no longer pivots with respect to the door 3 or the body 5 at this stage, pivoting drive is not transmitted between the pivots 19, 21.

[0063] In the hinging mode, the door pivot spindle 47b is free to pivot relative to the door 3 so that pivoting drive is not transmitted from the arm 17 to the door 3. However, the door 3 is attached to the arm 17 to arrest pivoting movement of the door 3 with respect to the arm 17 whilst the door 3 and the arm 17 pivot with respect to the body 5.

[0064] The relative motions of the gears 43, 45, 51, 53, 55, and the push-pull rod 61, with respect to the outer body gear 41 when the door 3 is opened from the closed position A to the intermediate position D, or the hinging open position B, are shown by the arrows in Figure 14.

[0065] When the arm 3 is moved from the closed position A, the arm 3 pivots about the body pivot 21 and the body pivot spindle 47a. The door pivot spindle 47a, and thus the outer body gear 41, are secured to the body 3. The outer body gear 41 pivots with respect to the arm 17 in an anti-clockwise direction in the view shown. The middle body gear 43, engaged with the outer body gear 41, is caused to pivot in a clockwise direction, and the inner body gear 45 is, in turn, caused to pivot in an anti-clockwise direction. The pivoting movement of the inner body gear 45 pulls the push-pull rod 61 towards the body side gear train 31, which in turn causes the inner door gear 55 to pivot in an anti-clockwise direction. Thus, the middle door gear 53 is caused to pivot in a clockwise direction, and the outer door gear 51 and the door pivot spindle 47b are caused to pivot in an anti-clockwise direction. When the arm 17 is moved back towards the closed position A, the components each move in the opposite direction from that described above.

[0066] When the selector handle 14 has been operated so that the pivot drive 23 is in a sliding mode, the door 3 is responsive to pivoting of the door pivot spindle 47b, to move the door 3 away from closed position A so that it maintains a substantially parallel relationship with respect to the body 5 as the arm 17 swings out from the body 5. When the selector handle 14 has been operated so that the pivot drive 23 is in the hinging mode, the door 3 is not responsive to the pivoting of the door pivot 19, so that the door 3 simply pivots about the body pivot 21. In the hinging mode, the transmission of pivoting drive from the body pivot 21 with respect to the arm 17 to the door pivot 19 is interrupted, so that the door 3 does not pivot with respect to the arm 3.

[0067] In Figure 15 the arm 17 and its pivot drive 23 are shown in plan view, without the upper plate 27, in the closed position A and an open position E (which is common to the hinging open position B and the intermediate position D). Features that are common to previous figures take the same reference numbers. A first arrow 69 shows the extent of the angular displacement of the arm 17 about the body pivot 21 between the closed position A and the open position E. A second arrow 71 shows the direction of movement of the push-pull rod 61 relative to the arm 17 as the arm 17 moves from the closed position A to the open position E.

[0068] Figure 16 shows the arm 17 of Figure 15 attached to a schematic representation of a door 3, with the pivot drive 23 operating in a hinging mode. Features that appear in previous figures take the same reference numbers. The arm 17, in moving from the closed position A to the hinging open position B, pivots about the body pivot 21. As the door 3 is attached to the arm 17 to prevent pivoting movement of the door 3 relative to the arm 17, and the selector handle 14 is operated so that pivoting drive is not transmitted to the door pivot 19, the door 3 is maintained in its position relative to the arm 17. So, on opening or closing the door 3 the door 3 pivots about the body pivot 21.

[0069] Referring to Figure 17, the arm 17 of Figure 15 is shown connected to a schematic representation of a door 3, with the pivot drive 23 operating in a sliding mode. Features that appear in previous figures take the same reference numbers. The arm 17 and the door 3 are shown in a closed position A, an intermediate position D and in transition in between. The selector handle 14 is operated so that pivoting of the body pivot 21 relative to the arm 17 is transmitted to drive the door pivot 19 relative to the arm 23, so that the door 3 pivots about the door pivot 19 as shown by a third arrow 73. The gearing of the pivot drive 23 is arranged so that the door 3 pivots about the door pivot 19 at the same speed as the arm 17 pivots about the body pivot 21, but in the opposite direction. Thus, the door 3 moves until the arm 17 is substantially perpendicular to the door 3 and to the side of the body 5.

[0070] In summary, relative pivotal movement between the arm 3 and the body pivot 21 is effected by pivoting the arm 3 with respect to the body 5 upon opening or closing the door 3. The pivot drive 23 is responsive to

the relative pivotal movement between the arm 3 and the body pivot 21 to act upon the door pivot 19 under the control of the selector handle 14. When the selector handle 14 is operated to select the sliding mode, the pivot drive 23 responds to relative pivotal movement between the arm 17 and the body pivot 21 to drive the relative pivotal movement between the door pivot 19 and the arm 17, and to cause relative pivotal movement of the door 3 with respect to the arm 17. However, when the selector handle 14 is operated to select the hinging mode, the pivot drive 23 responds by interrupting the relative pivotal movement of the door pivot 19 with respect to the arm 17 so that the door 17 is fixed with respect to the arm 17, and simply pivots about the body pivot 21 with respect to the body 5.

[0071] Figure 18 shows a typical linear slider 75, such as made by Accuride®, that is fitted to the door 3 and along which the door 3 slides between the intermediate position D and the slid open position C. Referring to Figures 19a, 19b and 19c, typically two linear sliders 75 are fitted to the door 3, one spaced above the other. An arm 17 is fitted to the upper linear slider 75, and a lower arm 18 is fitted to the lower linear slider, both arms 17, 18 connecting the door 3 to the body 5. However, the lower arm 18 does not comprise a pivot drive 23. In Figures 19a, 19b and 19c, the door 3 is shown to be operating as a sliding door, sliding from the intermediate position D illustrated in Figure 19a to the slid open position C shown in Figure 19c, through a position in which the door 3 is in transition between these two other positions, as illustrated in Figure 19b. A first bold arrow 77 shows the direction of travel of the door 3 relative to the body 5 in these three figures. However, the door 3 is obviously capable of travelling in the opposite direction. Note that the two sets of arms 3 and sliders 75 work in harmony during these movements.

[0072] Figures 20a, 20b and 20c show the same features as Figures 19a, 19b and 19c, except here the door 3 functions as a hinging door. The door 3 is shown in a closed position A, in Figure 20a, in a hinging open position B, in Figure 20c and in transition between these two positions in Figure 20b. A second bold arrow 79 in Figures 20b and 20c illustrates the pivoting motion of the door 3 about the door pivot 19 as the door 3 moves from the closed position A to the hinging open position B. The door 3 is capable of pivoting back, in the opposite direction, into the closed position A.

[0073] Referring to Figure 21, the extent of movement of the door 3 with respect to the body 5 in the hinging and the sliding modes is shown in plan view. The 'S' shaped arm of the preferred embodiment, here referenced as 17a, is shown superimposed on the representation of the arm 17 shown in Figure 3, and common features with Figure 3 take the same reference numbers. The position of the door pivot 19 and the body pivot 21 are the same as in Figure 3, but the 'S' shaped arm 17a is in a different position because it has two bends instead of the single bend of the arm 17. However, the functionality of the two arms 17, 17a is the same. The shape of the S-shaped arm 17a enables the arm 17a to be retrofitted to an existing vehicle by giving clearance around existing door aperture structures. Note also the position of the slider 75 relative to the door pivot 19 to enable the door 3 to slide relative to the arm 17 and the body 5 during transition between the intermediate position D and the slid open position C.

[0074] Referring to Figure 22, the door 3 is shown in the intermediate position D as in Figure 20a but in greater detail. Features present in Figure 22 that are also present in any of the aforementioned figures take the same reference numbers. The arm 17 and the lower arm 18 are each connected to the door 3 by way of a door bracket 81 and to the vehicle body 5 by a body bracket 83. Each door bracket 81 has a door plate 80 that is engaged with one of the sliders 75, and pivot apertures 82 for pivotal engagement to the door pivot 19 of the respective arm 17, 18 (note only the pivot aperture 82 for the lower arm 18 is shown in Figure 22). Each body bracket 83 has a body plate 84 for affixing to the body 5 and hinge apertures 86 for pivotal engagement to the body pivot 21 of the respective arm 17, 18. A locking collar 79 for use in selecting the mode of operation of the door 3 is located on the door pivot 19 and door bracket 81 of the arm 17.

[0075] Referring to Figure 23, the arm 17 and the lower arm 18 are shown each in the open position E with their respective door bracket 81 and body bracket 83, but without the door 3. Figures 24 and 25 have the same features as Figure 23, but are two different views of the arm 17 and the lower arm 18 when a door 3, to which the arms 17, 18 are attached in use, is in its closed position A.

[0076] Referring to Figure 26a, the locking collar 79 is essentially a right circular cylinder with planar end surfaces: an upper end surface 90, and a lower end surface 74. A circular collar aperture 95 is defined in the upper end surface 90 at the axis of rotation of the locking collar 79. An upper end of a locking pin 85 protrudes from the upper end surface 90.

[0077] Referring to Figure 26b, the lower end surface 74 of the locking collar 79 is shown. Two pins protrude from the surface 74: an engagement pin 88 and a lower end of the locking pin 85. A square cross-sectioned aperture 91 is defined at the rotational axis in the lower end surface 74. The pins 85, 88 are opposed about the aperture 91.

[0078] Referring to Figure 27, the arm 17 of Figures 22, 24 and 25 is shown in the closed position A (if it were attached to a door 3). The locking collar 79 is shown positioned on an upper surface 78 of the door bracket 81, over a door spindle 93 (as mentioned below).

[0079] Referring to Figure 28, the arm 17 is shown with the locking collar 79 removed from the bracket 81, revealing features of the door bracket 81, the square cross-sectioned spindle 93 and the locking collar 79. Defined in the upper surface 78 of the door bracket 81 are four engagement apertures 89 that are located equidistantly from, and are equi-angularly spaced about, a pivot ap-

erture 82. The spindle 93 extends from the pivot aperture 82, and it is an extension of the door pivot 19. The spindle 93 is shaped to engage in the correspondingly square shaped aperture 91 in the lower end surface 74 of the locking collar 79.

[0080] The pins 85, 88 are positioned on the lower end surface 74 of the locking collar 79 such that when the aperture 91 and the spindle 93 are aligned, the pins 85, 88 are each aligned with a respective one of the engagement apertures 89. Thus, as will be described in detail later, when the locking collar 79 is located sufficiently close to the upper surface 78 of door bracket 81, each of the pins 85, 88 may engage with the respective engagement apertures 89.

[0081] In Figure 29a, features of the locking collar 79 are illustrated. A passageway 76 connects the two end surfaces 90, 74, along the axis of rotation of the locking collar 79. Note the engagement pin 88 is also present on the lower end surface 74 of the collar 79, but it is not shown in this figure. A portion of the passageway 76 defined by the circular aperture 95 has a circular cross section, and the remainder of the passageway 76 defined by the aperture 91 has a square cross-section. Also defined in the locking collar 79 between the two end surfaces 74, 90 is a pin passageway 97 that is shaped to receive the locking pin 85. A collar spring 99 adjoins the lower end surface 74 of the collar 79.

[0082] Referring to Figure 29b, the locking collar 79 and the locking pin 85 are shown, the locking collar 79 having the same features as illustrated in Figure 29a. The locking pin 85 is slideably positioned within the pin passageway 97 and comprises a pin body 94, a pin neck 92 which is connected to the pin body 94, and an attachment 87 for securing to a cable (not shown). The attachment 87 is connected to the pin neck 92. Around the pin neck 92 is a pin spring 101. The pin spring 101 forces the pin body 94 away from the attachment 87, so that the pin body 94 extends from the lower end surface 74 of the collar 79 when no force is applied by way of a cable secured to the attachment 87. When the cable is pulled to apply a force to the attachment 87, the force works against the pin spring 101, retracting the pin body 94 into the pin passageway 97. When the force applied by the cable is relieved, the pin spring 101 moves the attachment 87 and the pin body 94 apart so that the pin body 94 again extends from the lower surface 74 of the collar 79.

[0083] Figure 30 shows the upper plate 27 of the arm 17 with a plurality of apertures 30 for the pins 29, the pivot aperture 82, the hinge aperture 86, a hinging aperture 103 and a sliding aperture 104. Both the hinging and sliding apertures 103, 104 are dimensioned to receive the body 94 of the locking pin 85.

[0084] When the upper plate 27 is fitted to the arm 17, the hinging aperture 103 is positioned under the upper surface 78 of the door bracket 81 so that the hinging aperture 103 is aligned with one of the engagement apertures 89. The locking pin 85 passes through both the hinging aperture 103 and the respective engagement aperture 89 to secure the door bracket 81 to the arm 17 and to hold the door 3 in position relative to the arm 17 is in its open position E. The arm 17 is shown in this configuration in Figure 23.

[0085] In the sliding mode, between the closed position A and the intermediate position D, the upper plate 27 and the arm 17 pivot with respect to the door bracket 81. In this transition, the locking pin 85 is not engaged with any of the engagement apertures 89, the hinging aperture 103, or the sliding aperture 104. The door 3 is free to pivot with respect to the arm 17.

[0086] Between the intermediate position D and the slid open position C, one of the engagement apertures 89 is aligned with the sliding aperture 104, and the locking pin 85 engages with them thereby preventing pivotal movement of the door bracket 81 with respect to the upper plate 27. So, the door 3 is secured so that it does not pivot relative to the arm 17.

[0087] Referring to Figure 31, features common to any of the aforementioned figures take the same reference numbers. The locking collar 79 is held above and its aperture 91 in the lower end surface 74 is aligned to engage with the spindle 93. The locking collar 79 is supported by the collar spring 99 and is held in place by a circular cross-sectioned collar shaft 107 that passes though the circular aperture 95. The collar shaft 107 comprises part of a collar bracket 105 which is attached to the door bracket 81.

[0088] Attached to the collar 79 is a collar cable 109. The collar cable 109 is under tension, so that when a force is applied to the cable 109, the collar 79 is urged against the bias of the collar spring 99 towards the upper surface 78 of the door bracket 81. When the spindle 93 and the aperture 91 are aligned and moved sufficiently close together they engage, permitting the collar 79 to be drawn sufficiently close to the upper surface 78 of the door bracket 81 so that the engagement pin 88 (not shown in this figure) engages with one of the engagement apertures 89 of the door bracket 81. When the tension in the collar cable 109 is released, the force applied to the collar spring 99 is relieved permitting the collar spring 99 to move the collar 79 away from the upper surface 78. The engagement pin 88 is then removed from the respective engagement aperture 89 and, with respect to the collar 79, the spindle 93 is removed from the aperture 91.

[0089] When drive is transmitted to the door pivot 19, the spindle 93 turns. So, when the locking collar 79 is fitted to the spindle 93, the locking collar 79 also turns. Since the engagement pin 88 of the locking collar 79 is engaged with one of the locking apertures 89, pivoting drive is transmitted to pivot the door bracket 81 and thus the door 3 with respect to the arm 17. Conversely, when the locking collar 79 is not fitted to the spindle 93, and the spindle 93 turns, drive is not transmitted to the collar 79, the bracket 81 or the door 3.

[0090] Figure 32 shows the same features as Figure

28, and common references numbers refer to the same features. In addition, Figure 32 indicates that the motion of the collar 79 is controlled by the collar cable 109 and collar spring 99. To enable transmission of the pivoting of the arm 17 with respect to the body 5 to pivot the door 3 with respect to the arm 17 between the closed position A and the intermediate position D, the collar 79 is fitted to the spindle 93. Thus, the locking collar 79 locks the spindle 93 with respect to the door bracket 81.

[0091] In Figure 33, features common to any of the aforementioned figures take the same reference numbers. The locking pin 85 is shown with a pin cable 111 secured to the attachment 87. The locking pin 85 is located above, and aligned with, one of the engagement apertures 89. As explained previously, when no tension is applied to the pin cable 111, the pin body 94 passes through one of the engagement apertures 89 and either the hinging aperture 103 or the sliding aperture 104. In Figure 33, the hinging aperture 103 is aligned with one of the engagement apertures 89. When tension is applied to the cable 111, the locking pin 85 is removed from the hinging aperture 103. When the tension is released, the body 94 of the locking pin 85 extends downwards, and when the door 3 is in its closed position A the pin body 94 passes through one of the engagement apertures 89 and the hinging aperture 103 to secure the arm 17 relative to the door bracket 81. If the door 3 is in the intermediate position D, the pin body 94 passes through one of the engagement apertures 89 and the sliding aperture 104, securing the arm 17 to the door 3 against pivoting motion. Note that the locking pin 85 moves independently of the locking collar 79, within the pin passageway 97.

[0092] Referring to Figure 34, the selector handle 14 of Figure 2 is shown in detail, in a left side door 3 of a vehicle. Attached to the selector handle 14 is a selector cable 113 which is connected to both the collar cable 109 and the pin cable 111. The selector handle 14 is pivotable between two positions, a hinging position and a sliding position. The hinging position is shown in Figure 34. When the selector handle 14 is moved from the hinging position to the sliding position, the selector handle 14 is pivoted upwards to apply a tension to the selector cable 113. For the selector handle 14 shown in Figure 34, pivoting the selector handle 14 anti-clockwise pulls the selector cable 113, applying a tension to the cable 113. Pivoting the selector handle 14 back in a clockwise direction releases cable 113, relieving the tension.

[0093] Since the cable 113 is connected to the pin cable 111 and the collar cable 109, moving the selector handle 14 between its hinging position and its sliding position operates the locking collar 79 and the locking pin 85 simultaneously. By operating the selector handle 14 when the door 3 is in its closed position A, the mode of operation of the door 3 is selected.

[0094] In the hinging mode, the selector handle 14 is used as an internal handle to open the door 3 from within the vehicle 1. The selector handle 14 operates in a normal lever action to unlatch the door 3 whereupon the pressure of, for example, a user's elbow or forearm may be used to open the door 3 in the usual way. To open the door 3 from outside the vehicle 1, the external handle 7 is used to unlatch the door and pull the door open.

[0095] In the sliding mode with the selector handle 14 pivoted anti-clockwise, as shown in Figure 35, the door 3 is opened from within the vehicle 1 by applying a light force, for example by a user's foot and leg, to the front bottom corner of the door 3. In response to the application of that force, the door 3 moves out towards the intermediate position D, as shown by arrow 119. Once the door 3 is in the intermediate position D, the selector handle 14 is then pivoted into its hinging position to disengage the locking collar 79 from the spindle 93. At the same time, the locking pin 94 engages with the door bracket 81. So, the arm 17 is in fixed angular relation with respect to the door 3, preventing the door 3 from pivoting with respect to the arm 17 when sliding door 3 into the slid open position C. Once the door 3 has been secured to the arm 17, a simple latch system (not shown) using solenoids and limit switches operates to permit the door 3 to move along the sliders 75.

[0096] Referring to Figure 36, the position of the external handle 7 and the side mirror 9 on the exterior of the door 3 are shown. On its underside the side mirror 9 has a pivotable selection handle 115 that is pivotable about a pivot axis near an outer end of the side mirror 9 furthest from the door 3. The selection handle 115 has a hinging position and a sliding position. In the hinging position, the selection handle 115 is in the plane of the side mirror 9, and in the sliding position (as illustrated in Figure 36) the selection handle 115 is pivoted relative to the side mirror 9, in the direction of arrow 117. The selection handle 115 is connected to the selector cable 113, and thus to the collar cable 109 and the pin cable 111, via a pulley system (not shown) within the side mirror 9 and through a wiring harness aperture (not shown) in the door 3. By having the selection handle 115 in its hinging position, when the door 3 is in its closed position A, the pivot drive 23 operates in the hinging mode of operation; when the selection handle 115 is in its sliding position, the pivot drive 23 is in its sliding mode.

[0097] Figure 37 and 38 are detailed representations of the side mirror 9, and features common to previously described figures take the same reference numbers. Note that the selection handle 115 has indentations 121 that facilitate a user to grip the selection handle 115.

[0098] To open the door 3 as a hinging door from outside the vehicle 1, the selection handle 115 is in its hinging position, and the external handle 7 is used to operate the door 3. In the sliding mode, the selection handle 115 is in its sliding position. An outward pulling force is then applied to the selection handle 115 to drive the pivot drive 23, and move the door 3 from its closed position A to the intermediate position D. Note that the location of the selection handle 115 is in broadly the same vertical plane as the internal part of the door 3 to which a user would apply a light force (as in Figure 35) to operate the 3 door

as a sliding door from within the vehicle 1. The application of force here helps to operate the pivot drive 23 correctly. Once the door 3 is in its intermediate position D, the selection handle 115 is moved to its hinging position, in order to operate the locking collar 79 and the locking pin 85. This prevents the door 3 from pivoting with respect to the arm 17 when the door 3 is slid into its slid open position C.

[0099] Having described the preferred embodiment of the present invention, it is to be appreciated that the embodiment in question is exemplary only and that variations and modifications, such as will occur to those possessed of the appropriate knowledge and skills, may be made without departure from the scope of the invention as set forth in the appended claims.

[0100] For example, the arm 17 and the pivot drive 23 may be contained within the door 3 during its hinging mode of operation. The arm 17, or the pivot drive 23, or both, may be integral parts of the door 3. The arm 17 may any suitable shape and need not be 'S' shaped: this shape is required by the vehicle 1 of the preferred embodiment to accommodate an interfering pillar in a retrofit scenario.

[0101] A detent or check arm may be integrated into the arm 17 so as to resist unwanted movement when the door 3 is operating as a hinged door. One embodiment of the detent or check arm includes a flexible, resilient leaf spring which bears against the rim of a notched disc fitted to the spindle of one of the rotary components, such as one of the gears of the gear trains 31, 35. As the door 3 is hinged opened or closed, the leaf spring passes over the notches of the disc to engage with the disc in one of the notches corresponding to a desired, predetermined opening position, thereby holding the door in that predetermined position. The door is moved from its predetermined position by applying a force sufficient to remove the leaf spring from the notch.

[0102] In another embodiment, the detent or check arm is a hydraulic damper that is located in one of the rotary components of the pivot drive 23. The hydraulic damper is arranged to resist sudden motion of the door 3, and is able to hold the door 3 in any position between the closed position A and the hinged open position B. Once the damper has hold of the door 3 in a desired position, a minimum force is required in order to overcome the resistance of the hydraulic damper and so to move the door 3.

[0103] The preferred embodiment is described for a left side door of a vehicle. However the components and operation of the arm 17 and its pivot drive 23 for a right side of a vehicle are precisely the same, except the arm 17 is a mirror image, and the components of the pivot drive 23 pivot in the opposite sense to the described embodiment.

[0104] To simplify the selection of a mode of operation of the door 3, the mechanism 16 may comprise solenoids and limit switches that may operate in a predetermined manner and order to ensure that the pivot drive 23 operates in the selected mode of operation. The solenoids and limit switches may operate once selector handle 14 or the pivotable handle 117 has selected a mode of operation.

[0105] One or more than two arms 17 may be used to secure the door 3 to the vehicle body 5. Of these arms, at least one comprises a pivot drive 23.

[0106] The pivot drive 23 may be different from the preferred embodiment, although having the same functionality. It may have fewer components and fewer moving parts and may, for example, be embodied as a parallelogram linkage.

[0107] The pivot drive 23 that transmits the pivoting motion between the door pivot 19 and the body pivot 21 in the preferred embodiment is mechanical. However a hydraulic, pneumatic, electrical or any other sort of drive may be used.

[0108] In one electrical embodiment of pivot drive, the pivot drive 23 may comprise at least one electric motor, at the door pivot 19 or the body pivot 21. A motor located at the door pivot 19 to turn the door 3 about the door pivot 19 with respect to the arm 17 is responsive in the sliding mode to pivoting of the arm 17 with respect to the body 5. A motor located at the body pivot 21 drives pivoting of the arm 17 with respect to the body 5 about the body pivot 21. In another embodiment, a motor is located at each of the pivots 19, 21. In a variant of these embodiments, the motor is a hydraulic or pneumatic actuated motor.

[0109] All electrical components, such as the motors, solenoids, and limit switches may be computer operable, controlled by an on-board processing unit of the vehicle.

[0110] Features of the door 3, for example the side mirror 9, may require power to operate, and may communicate electronically with other components located elsewhere in the vehicle, for example its on-board processing unit. To minimise and to tidy the wiring for transmitting power and electronic signals between the components in the door 3 and the rest of the vehicle 1, the wiring may be integrated with the arm 17 connecting the door 3 to the body 5. To further minimise wiring, the arm 17 may have contact pads that are positioned to align with corresponding contact pads located on the body 5 and/or the door 3. So when the contact pads of the arm 17 are aligned with the corresponding contacts on the door 3 and/or the vehicle body 5, the contacts cooperate so as to conduct power and/or signals.

Claims

1. A selector mechanism, associated with a swinging arm that attaches a door to a vehicle, for selectably coupling a vehicle door and a door pivot to operate the door either as a sliding door or as a hinged door, the mechanism comprising a latch for selectably latching the vehicle door to the swinging arm, the mechanism having a coupling, unlatched state and

a decoupling, latched state, wherein:

a) in the coupling, unlatched state, the latch partially releases the door from the arm so the mechanism couples the door pivot to the door so that pivoting of the door pivot, with respect to the arm, is transmitted to the door so that the door can operate as a sliding door; and
b) in the decoupling, latched state, the latch latches the door to the arm so the mechanism decouples the door pivot from the door so that pivoting of the door pivot, with respect to the arm, is not transmitted to the door when the door operates as a hinging door.

2. The mechanism of Claim 1, further comprising a coupling operable to engage the door pivot to the door in the coupling state so as to transmit pivoting drive between the door pivot and the door, and to disengage the door pivot from the door in the decoupling state when pivoting drive is not to be transmitted.

3. The mechanism of Claim 2, wherein in the coupling state the coupling is engaged by inter-engagement of a complementary recess and protrusion.

4. The mechanism of Claim 3, wherein the recess and the protrusion are each shaped to have at least one flat so that when the recess and protrusion are engaged, pivoting drive may be positively transmitted therebetween.

5. The mechanism of any of Claims 2 to 4, further comprising a pivot connector for engaging with the door pivot.

6. The mechanism of Claim 5, wherein the coupling is associated with the pivot connector.

7. The mechanism of any preceding Claim, wherein the mechanism is pivotable about a rotational axis of the door pivot.

8. The mechanism of Claim 7, wherein at least part of the mechanism moves substantially parallel to the rotational axis to couple the door pivot to the door and to decouple the door pivot from the door.

9. The mechanism of Claim 8, wherein a spindle lies on the rotational axis and the mechanism includes a female part co-operable with the spindle for coupling.

10. A mechanism for selectably operating a door as a sliding door or as a hinged door with respect to a body such as a vehicle fitted with such a door, the mechanism comprising:

an arm having a door pivot that is pivotally movable with respect to the arm to cause pivotal movement of an attached door with respect to the arm, and a body pivot spaced from the door pivot for pivotal attachment of the arm to the body whereby the arm is pivotable with respect to the body upon opening or closing the door;
a selector according to any one of claims 1 to 9 for selecting between sliding and hinging modes of operation; and
a door pivot drive acting upon the door pivot under the control of the selector, the selector being arranged independently from the door pivot drive;

wherein, in the sliding mode, the door pivot drive drives relative pivotal movement between the door pivot and the arm, this in turn causing relative pivotal movement of the door with respect to the arm when the door is moved from a closed position by the arm upon opening to position the door for sliding movement with respect to the body, and conversely upon closing, and the door pivot drive acts upon the door pivot in response to the relative pivotal movement between the arm and the body; and
in the hinging mode, upon opening, and upon closing, the door is caused to pivot relative to the body without sliding.

11. The mechanism of claim 10, wherein the door pivot drive is mechanical.

12. The mechanism of Claim 10 or Claim 11, wherein when in the sliding mode as determined via the selector, relative pivotal movement between the arm and the body pivot is effected by pivoting the arm with respect to the body upon opening or closing the door; the door pivot drive is responsive to the relative pivotal movement between the arm and the body pivot to act upon the door pivot under the control of the selector; and in the sliding mode, the door pivot drive responds to relative pivotal movement between the arm and the body pivot to drive the relative pivotal movement between the door pivot and the arm that causes relative pivotal movement of the door with respect to the arm.

13. The mechanism of Claim 1 or Claim 2, wherein the door pivot drive transmits to the door pivot relative pivoting movement of the body pivot with respect to the arm.

14. The mechanism of Claims 13, wherein the arm includes at least one bend and the door pivot drive transmits drive along the arm and around said bend.

15. The mechanism of any preceding Claim, wherein, in the sliding mode, when the door is moved from its

closed position by the arm upon opening, the door is moved outwardly from the body to position it for sliding movement with respect to the body.

16. A selector handle for use with a mechanism according to anyone of claims 10 to 15, the selector handle configured to enable selection between sliding and hinging modes of operation of a vehicle door attached to a vehicle body, the handle comprising a control element operable to release the door for opening movement, wherein the control element is pivotable between a sliding position in which the control element is operable to open the door by sliding and a hinging position in which the control element is operable to open the door by hinging.

17. The handle of any preceding claim, wherein movement of the control element between the sliding and hinging positions transmits a control signal for controlling a hinging/sliding selector mechanism according to any one of claims 1 to 9.

18. The handle of Claim 17, wherein the signal is transmitted by transmitting a force to the selector mechanism.

19. The handle of any one of claims 16 to 18, being part of a side mirror attached to the door.

20. The door having a handle according to any one of claims 16 to 19, further comprising a location for pulling the door when the door operates as a sliding door so as to move the door from the closed position into position for sliding movement with respect to the body.

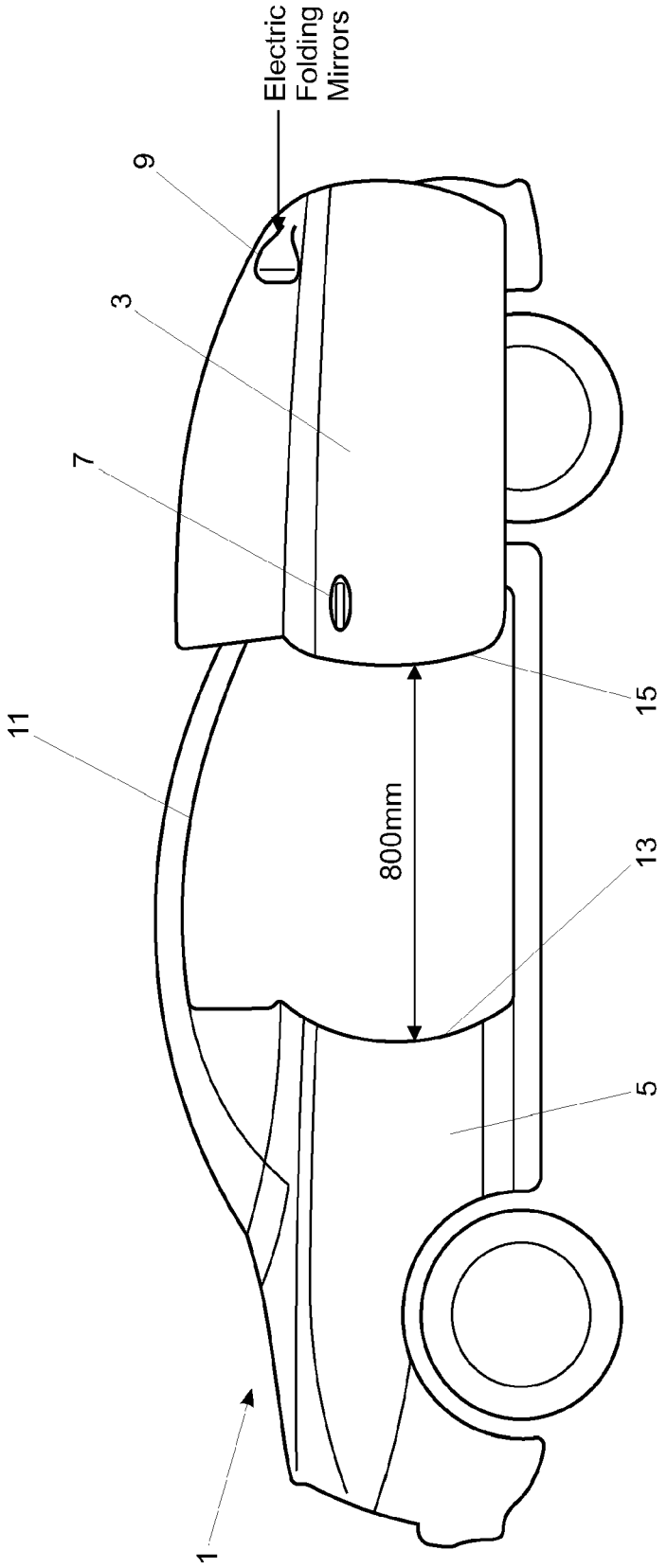


Fig.1

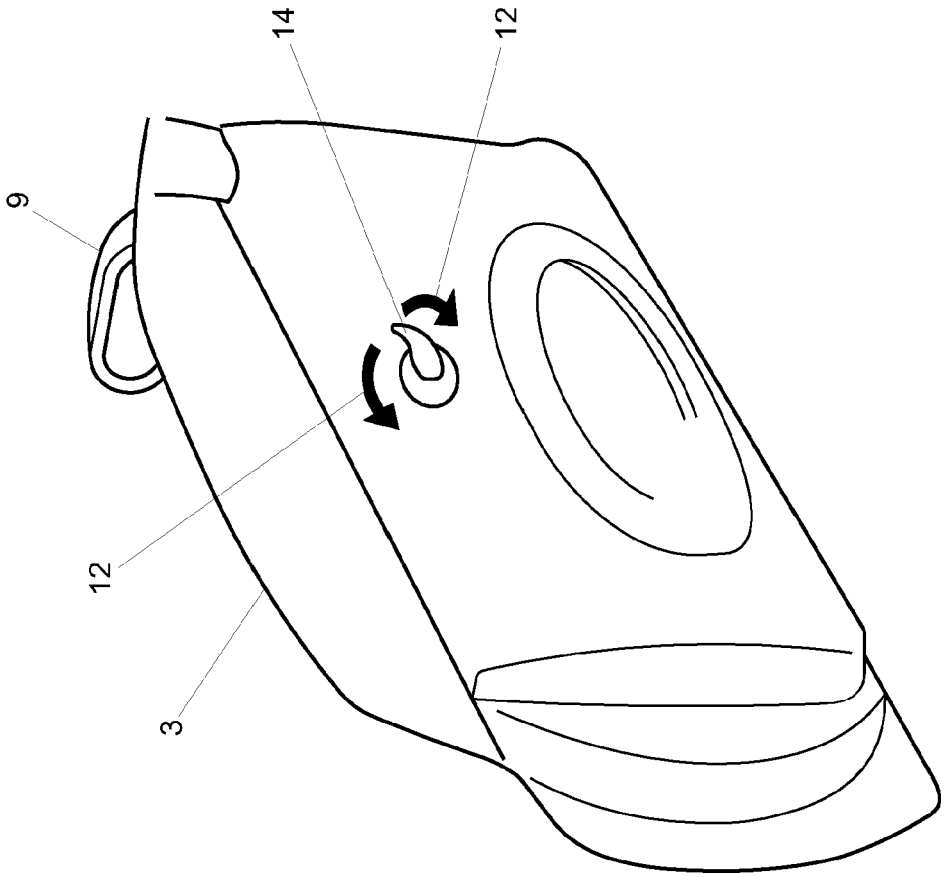


Fig.2

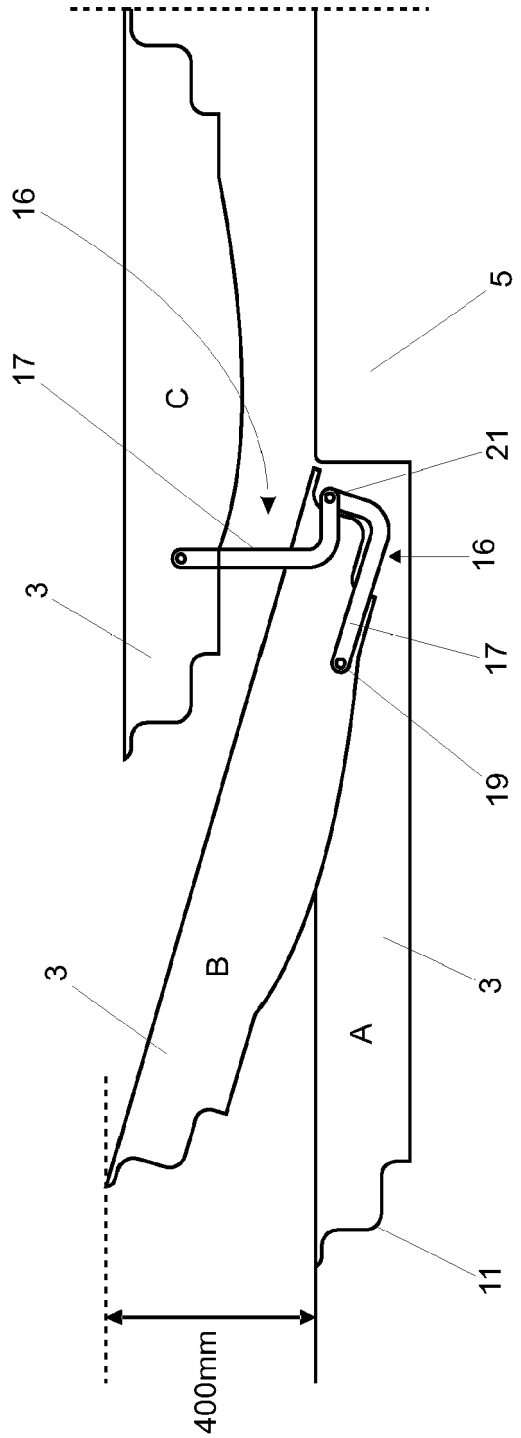
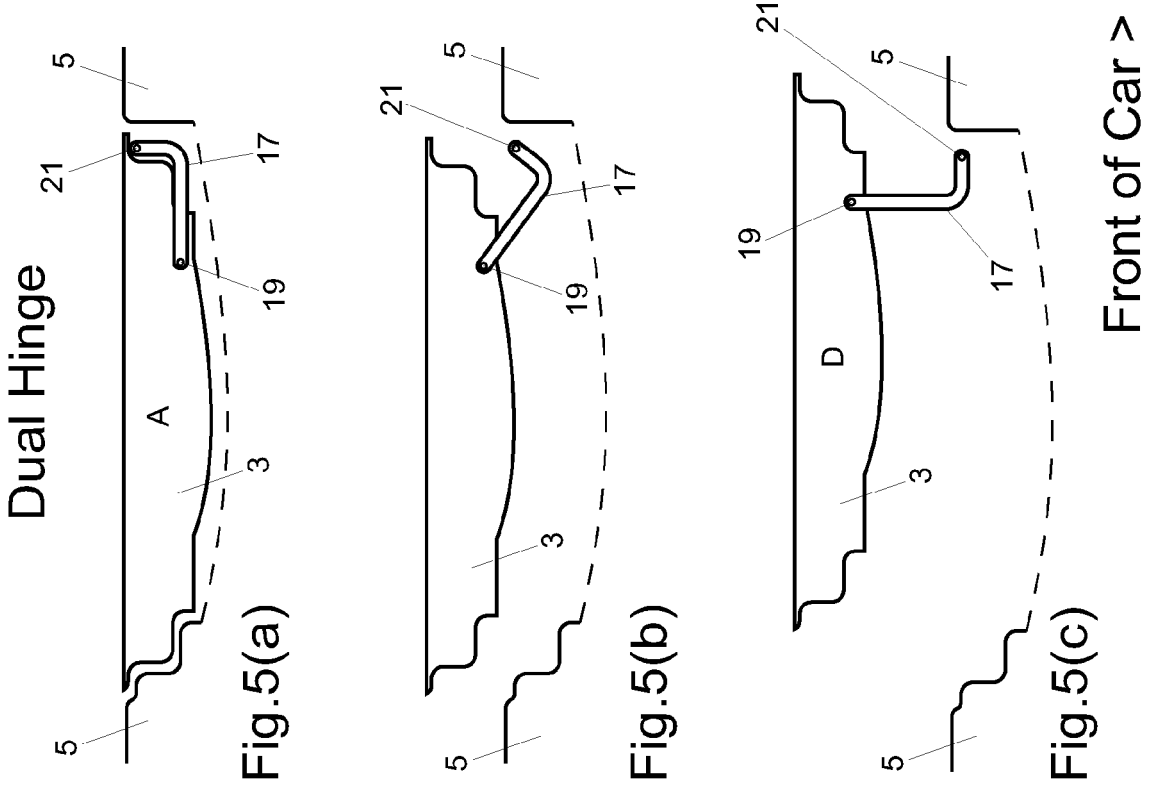
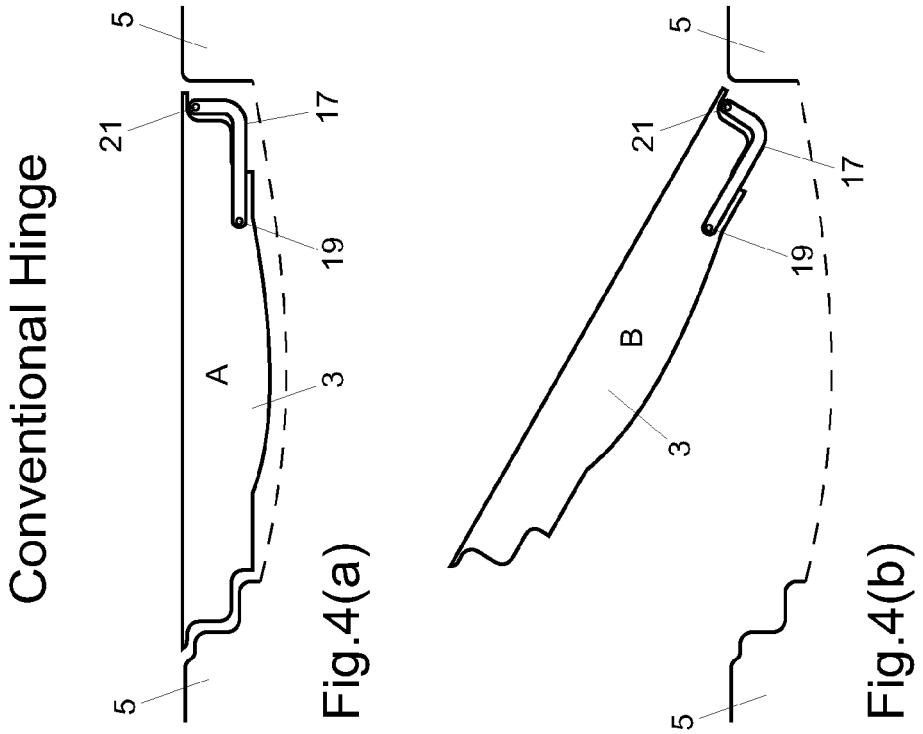


Fig.3


Dual Hinge
5
21
17
19
A
3
5
Fig.5(a)
5
21
17
19
3
5
Fig.5(b)
21
5
19
17
D
3
5
Fig.5(c)
Front of Car >


Conventional Hinge
5
21
17
19
A
3
5
Fig.4(a)
5
21
17
19
B
3
5
Fig.4(b)

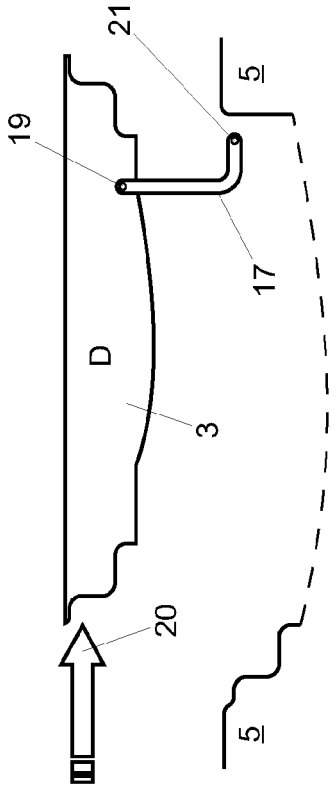


Fig.6(a)

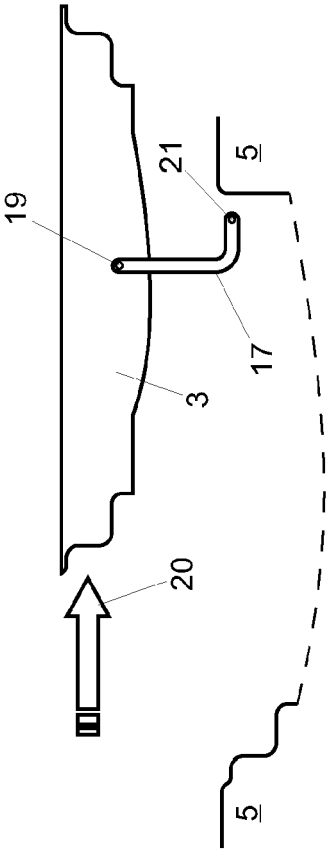


Fig.6(b)

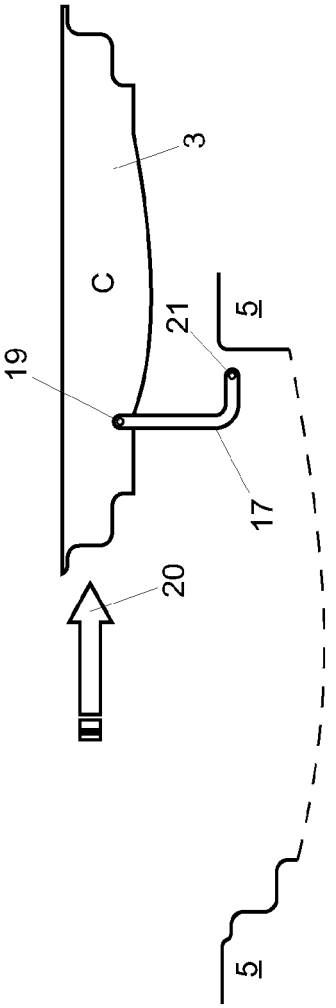


Fig.6(c)

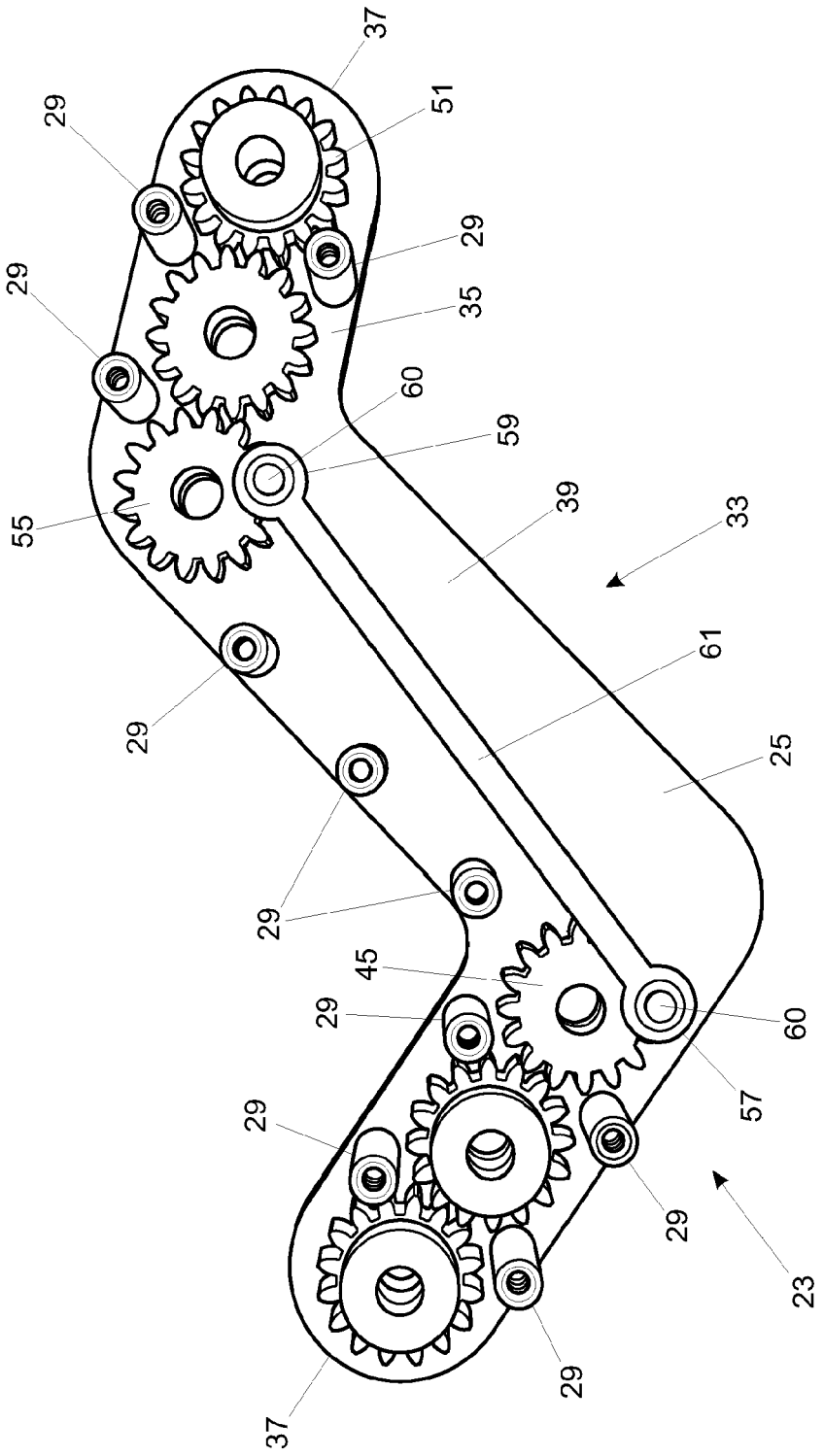


Fig.7

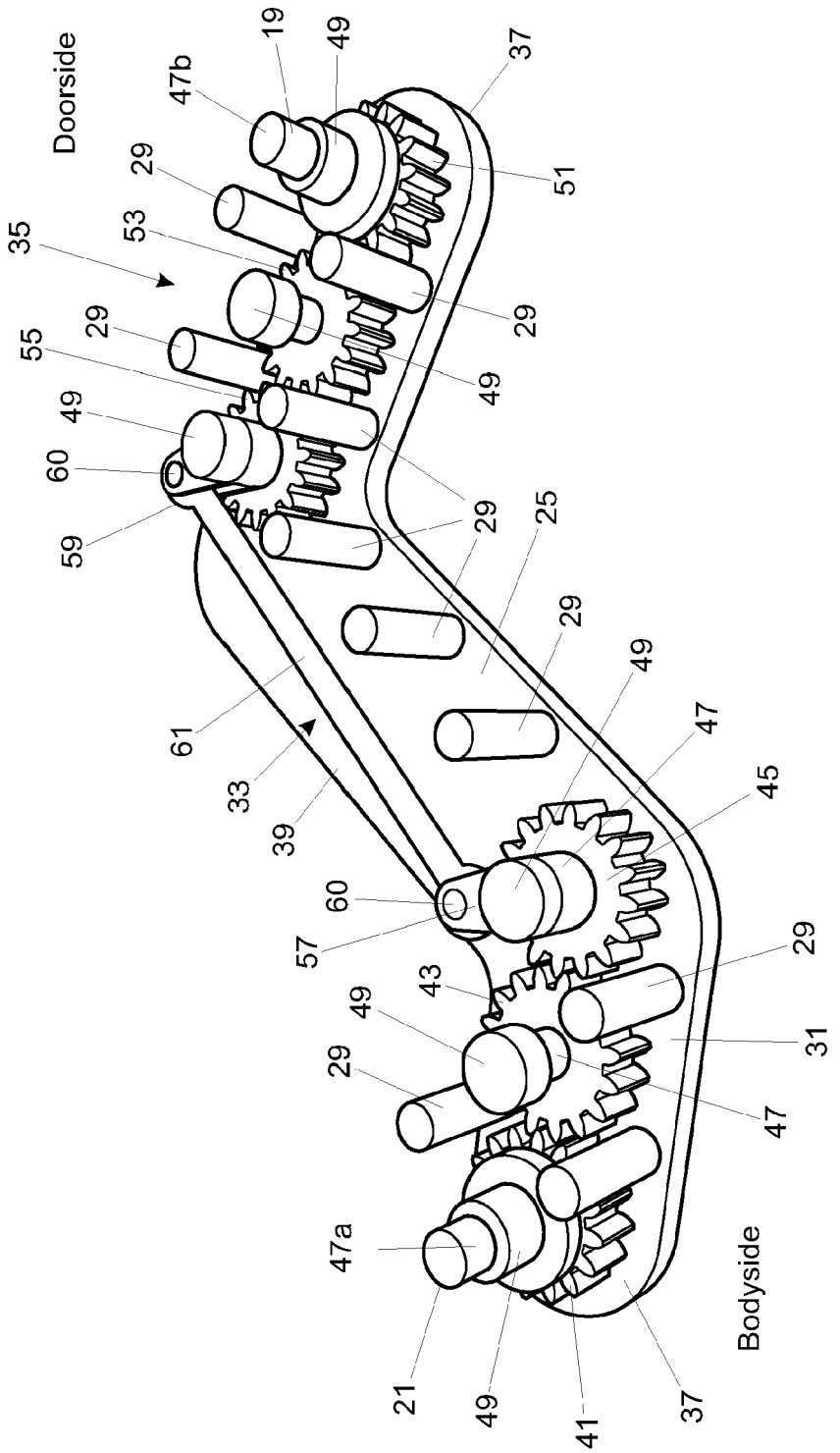

Doorside
Bodyside
19
49
37
47b
29
51
53
35
29
29
55
49
49
60
59
29
25
29
49
61
47
33
45
39
60
57
29
43
49
31
29
47
47a
21
49
41
37

Fig.8

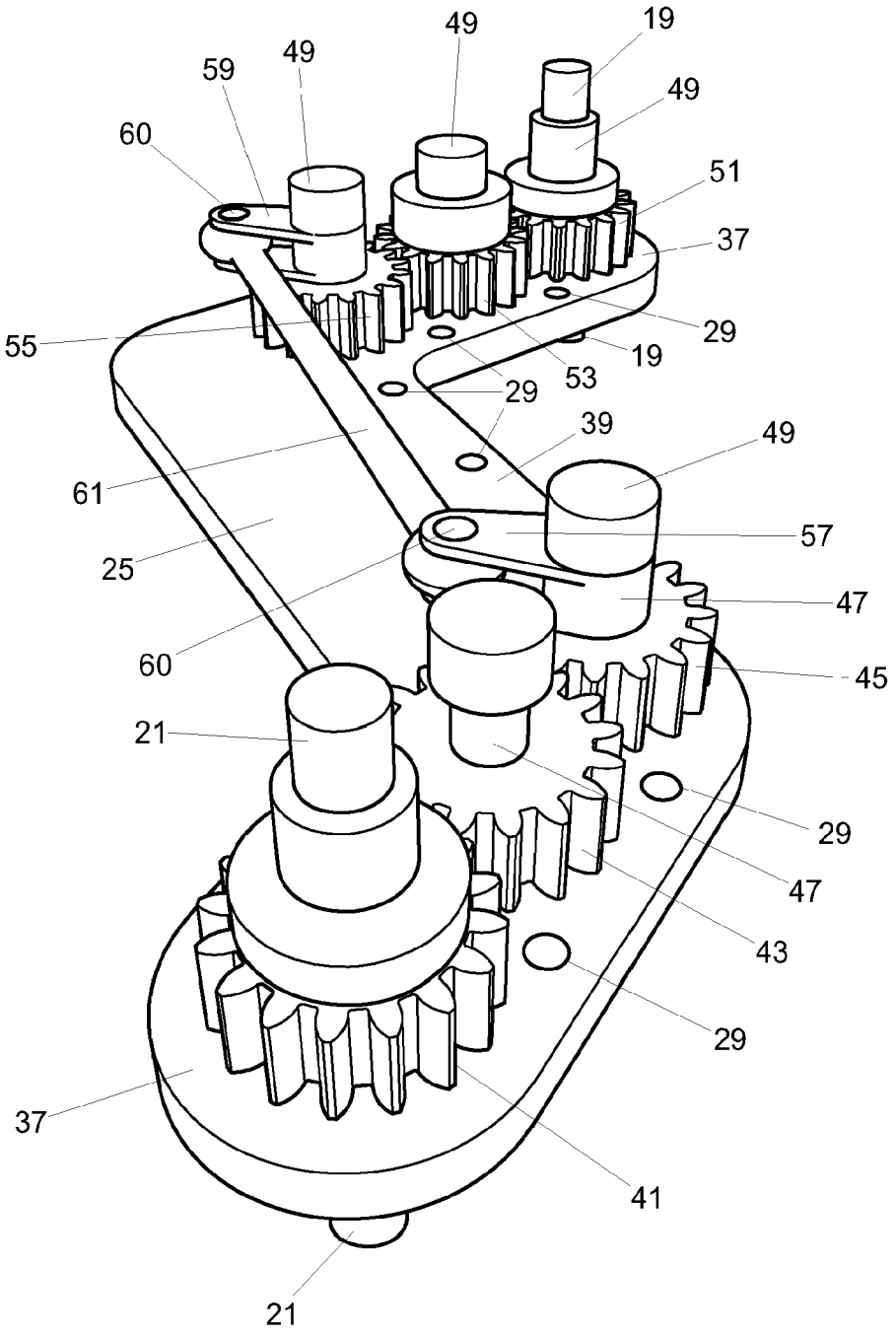

49
19
49
59
49
60
51
37
55
29
19
53
29
39
49
61
57
25
47
60
45
21
29
47
43
29
37
41
21

Fig.9

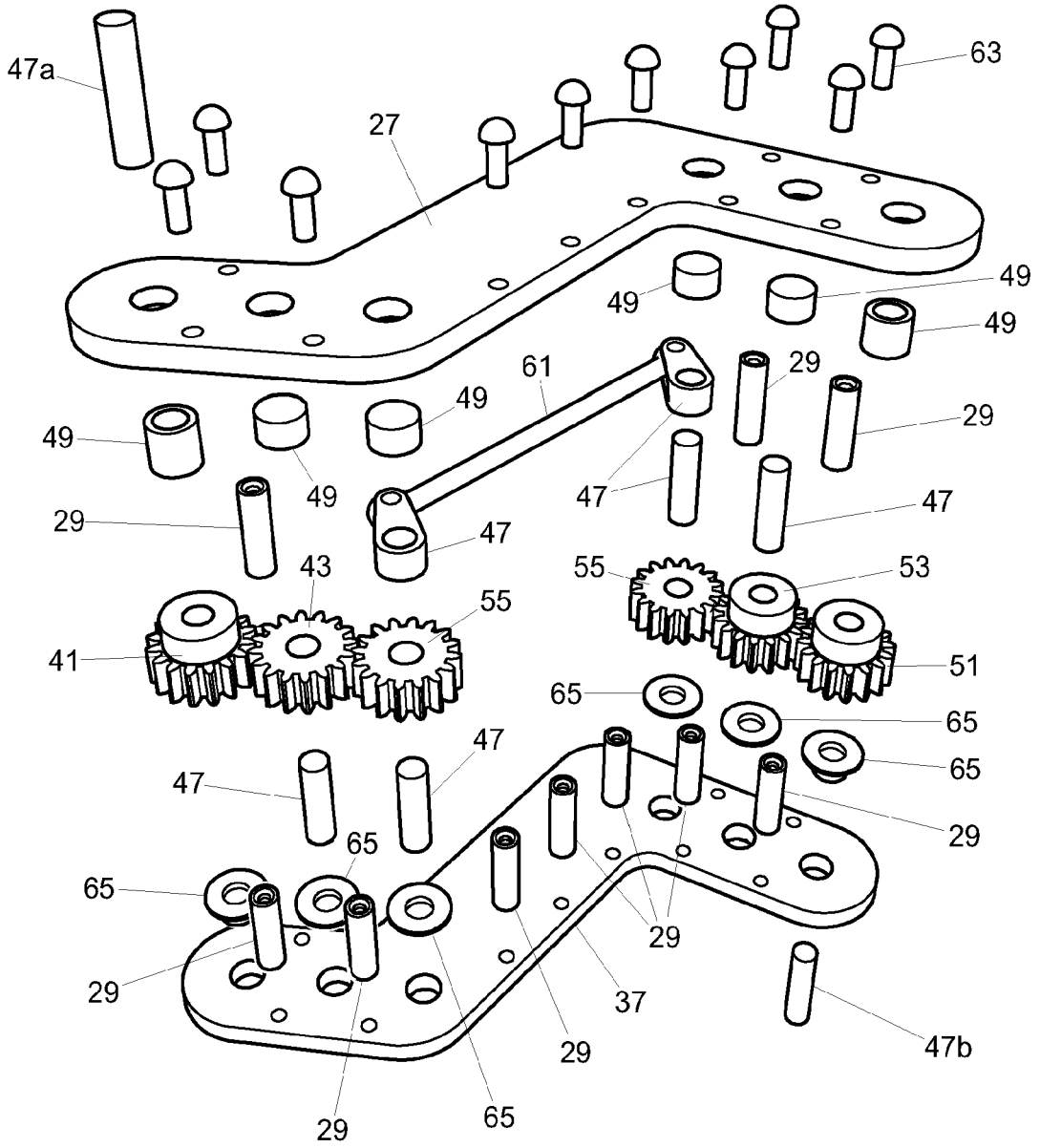

47a
27
63
49
49
49
61
29
49
49
29
29
49
47
47
47
29
47
43
55
53
55
41
51
65
65
65
47
47
65
29
65
29
29
37
29
47b
29
65

Fig.10

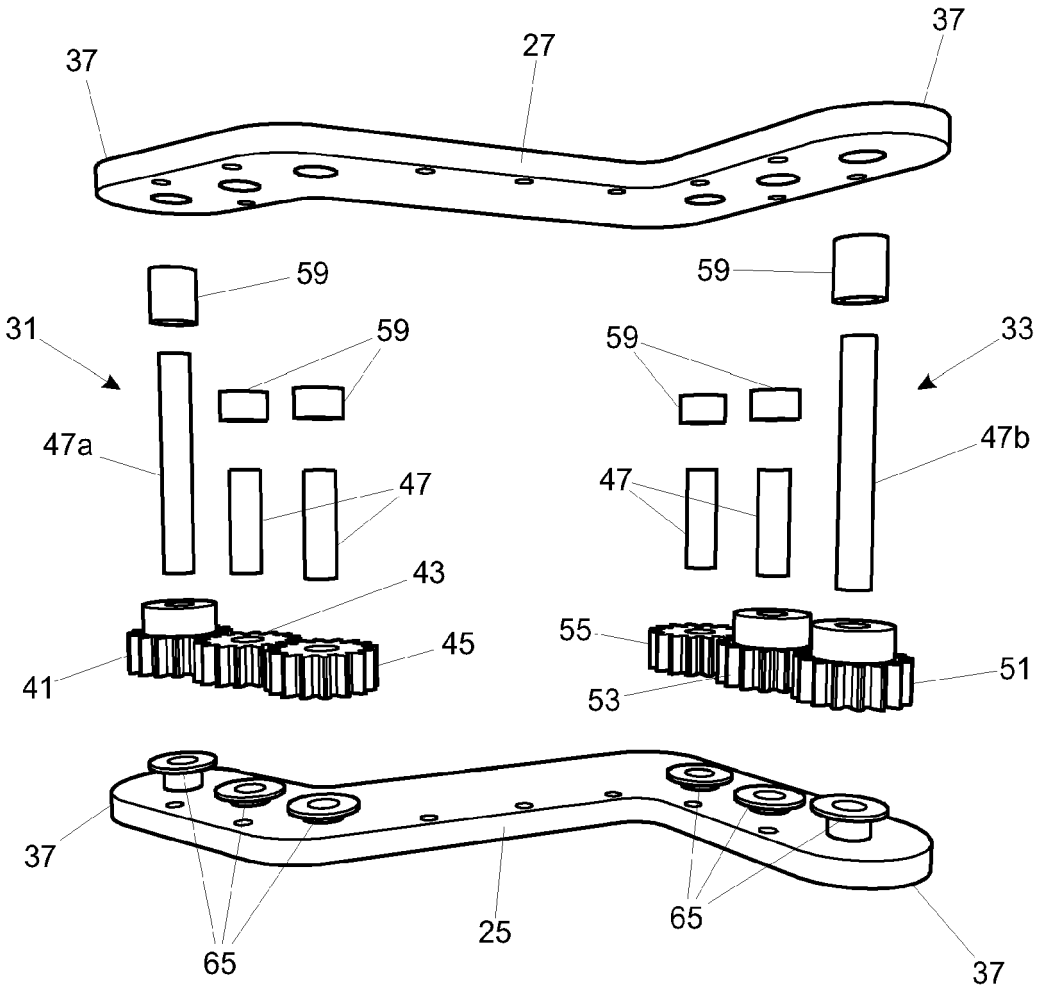

37
27
37
59
59
31
59
59
33
47a
47
47
47b
43
55
45
41
51
53
37
25
65
65
37

Fig.11

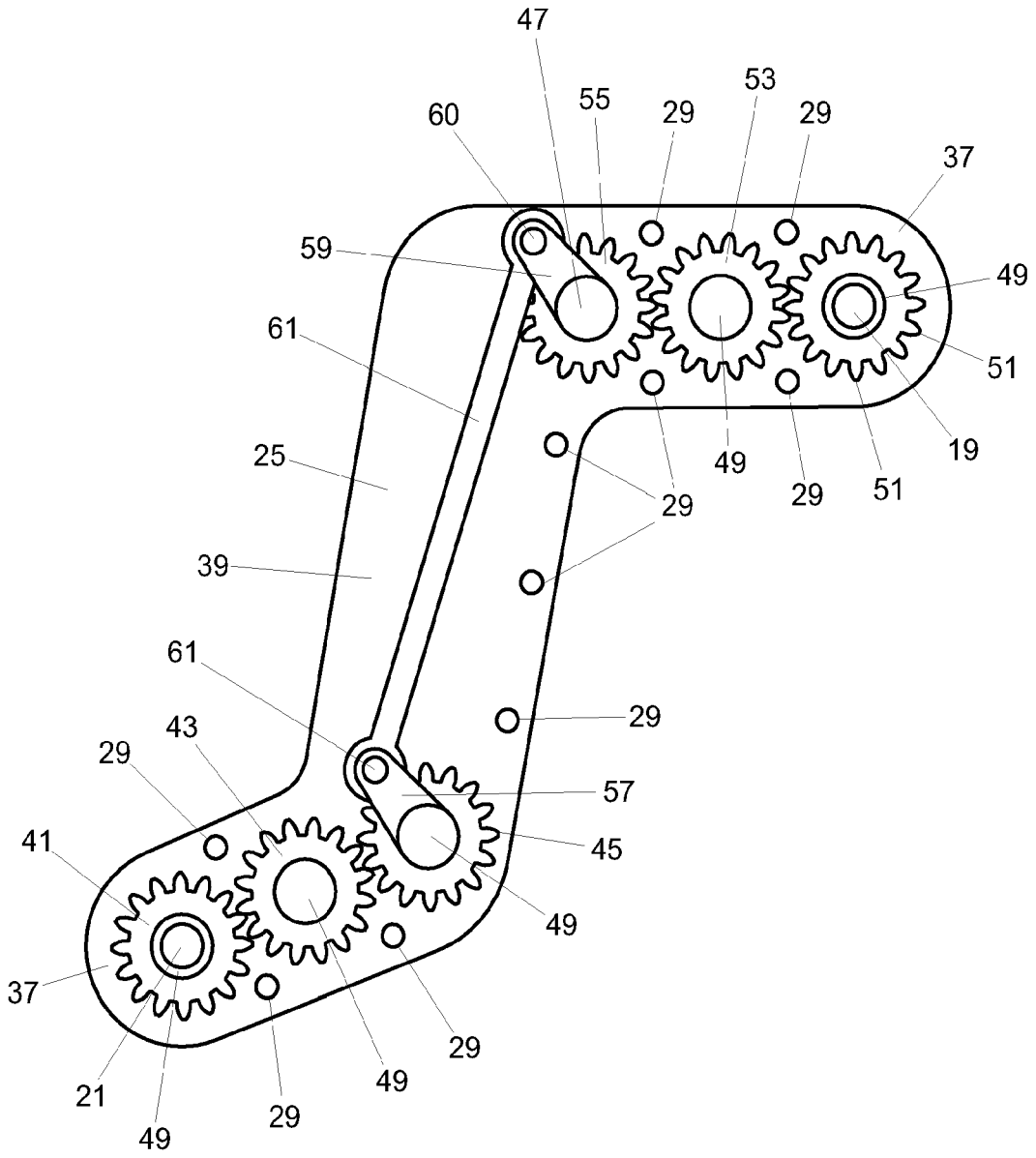

47
60
55
29
53
29
37
59
49
61
51
25
49
29
51
19
29
39
61
29
43
29
57
41
45
49
37
29
21
49
29
49

Fig.12

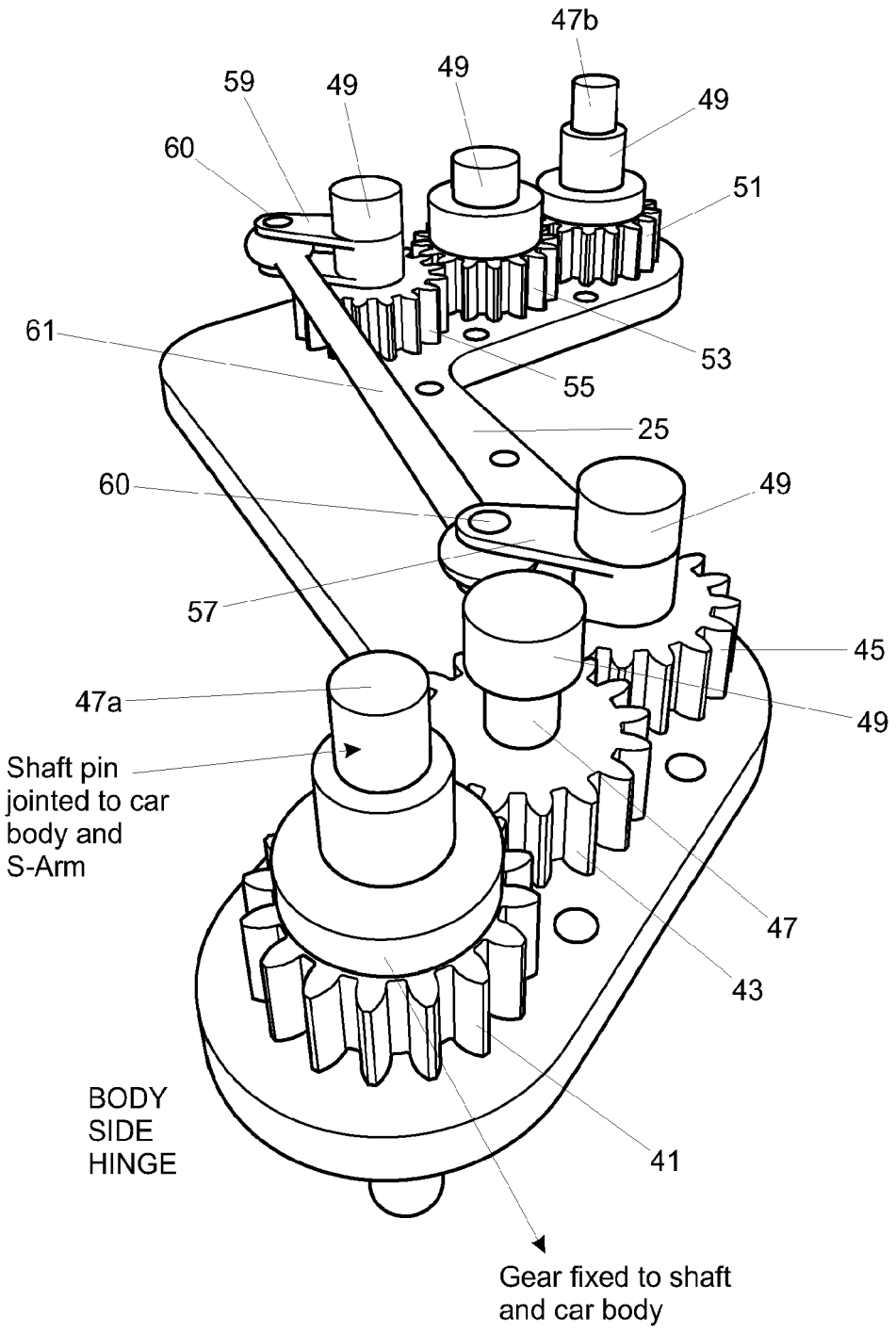

47b
59
49
49
49
60
51
61
53
55
25
60
49
57
45
47a
49
Shaft pin jointed to car body and S-Arm
47
43
BODY SIDE HINGE
41
Gear fixed to shaft and car body

Fig.13

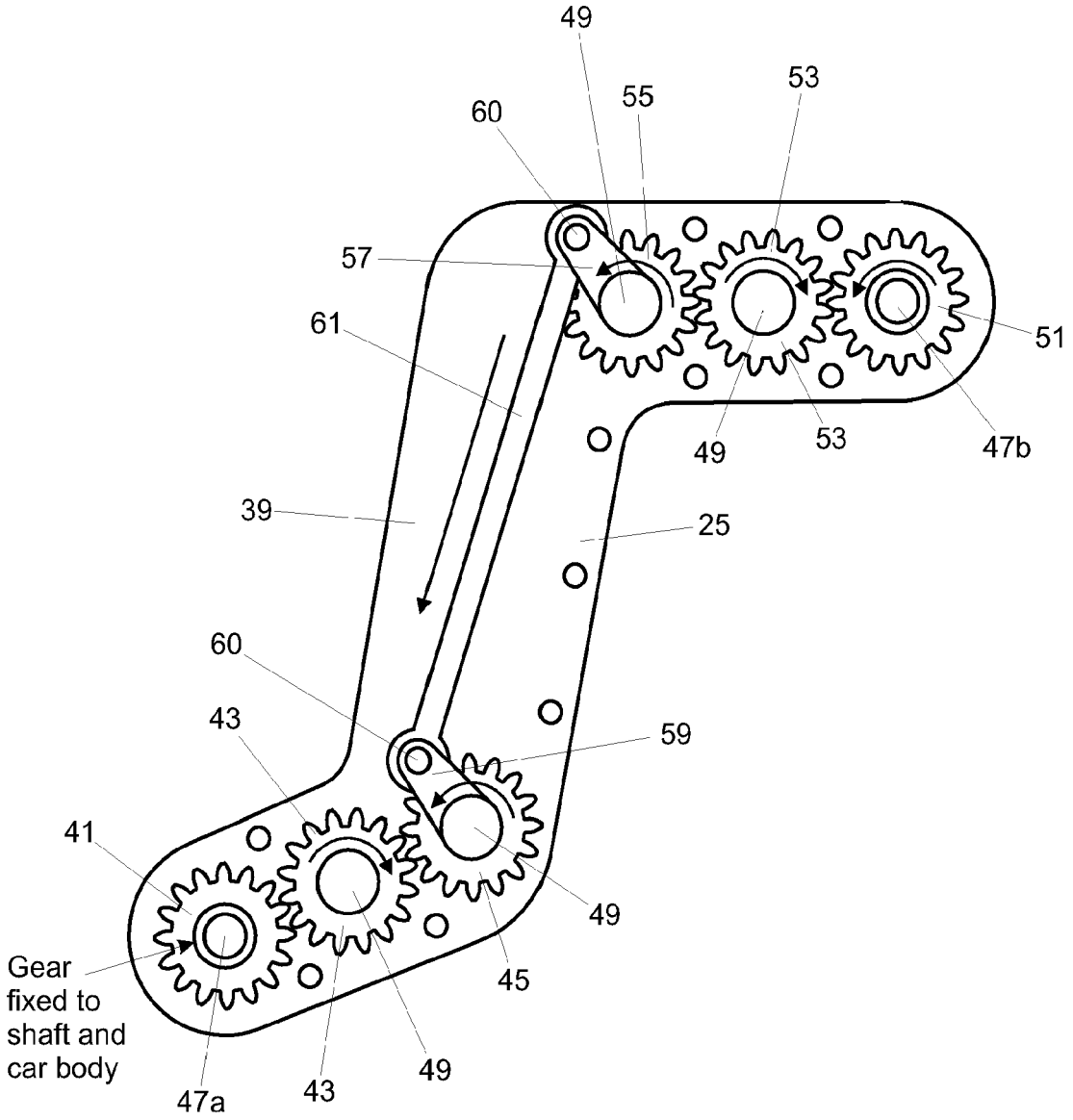

49
53
55
60
57
61
51
49
53
47b
39
25
60
43
59
41
49
45
Gear
fixed to
shaft and
car body
47a
43
49

Fig.14

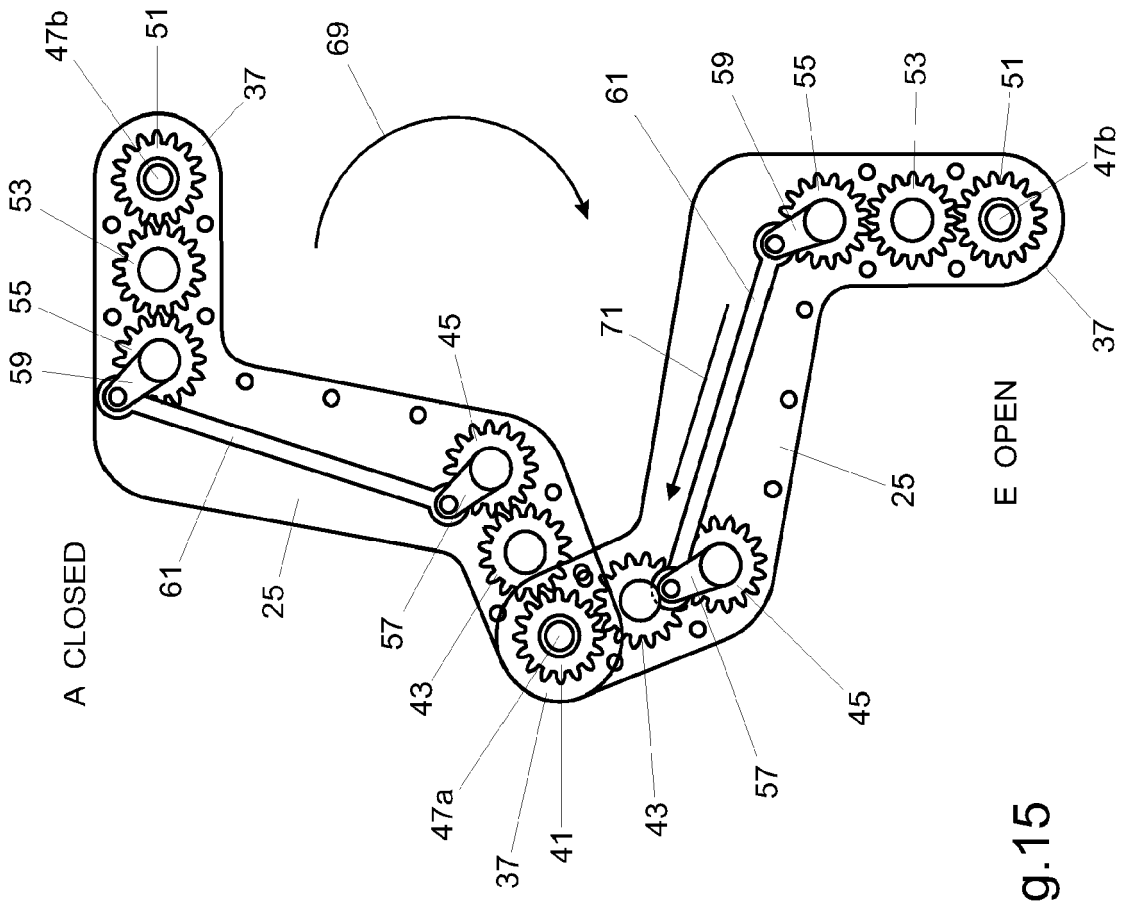


Fig.15

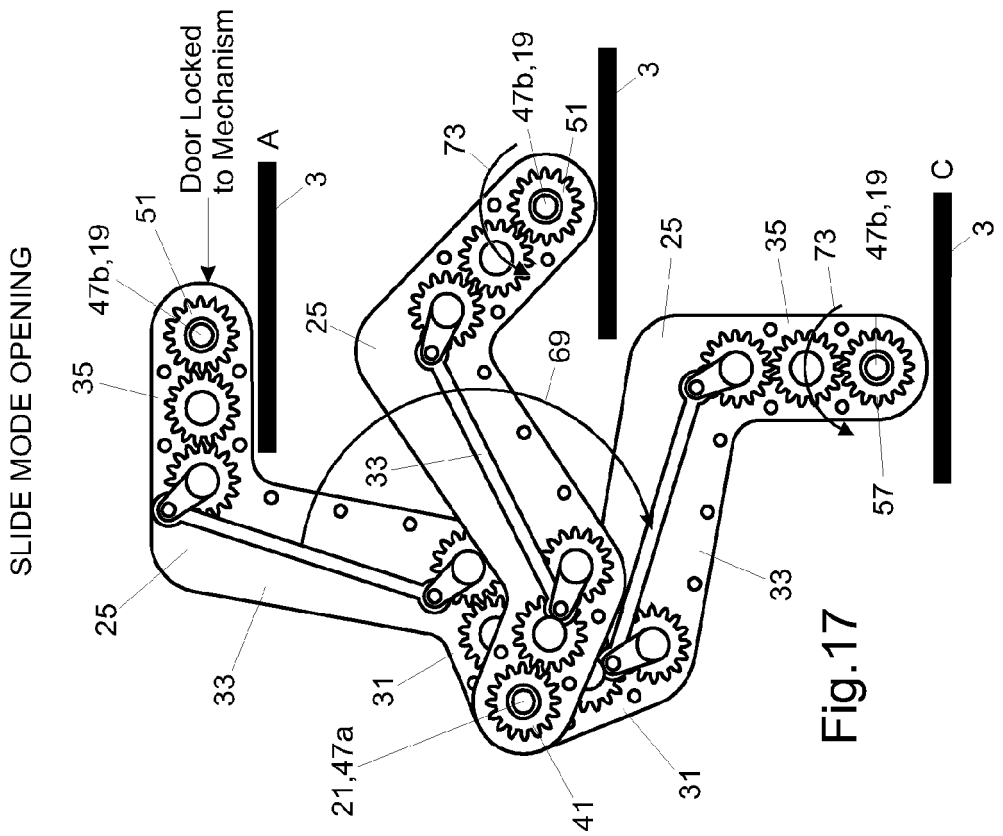

SLIDE MODE OPENING
Door Locked to Mechanism
A
3
51
47b,19
35
25
33
31
21,47a
41
73
69
57
C

Fig.17

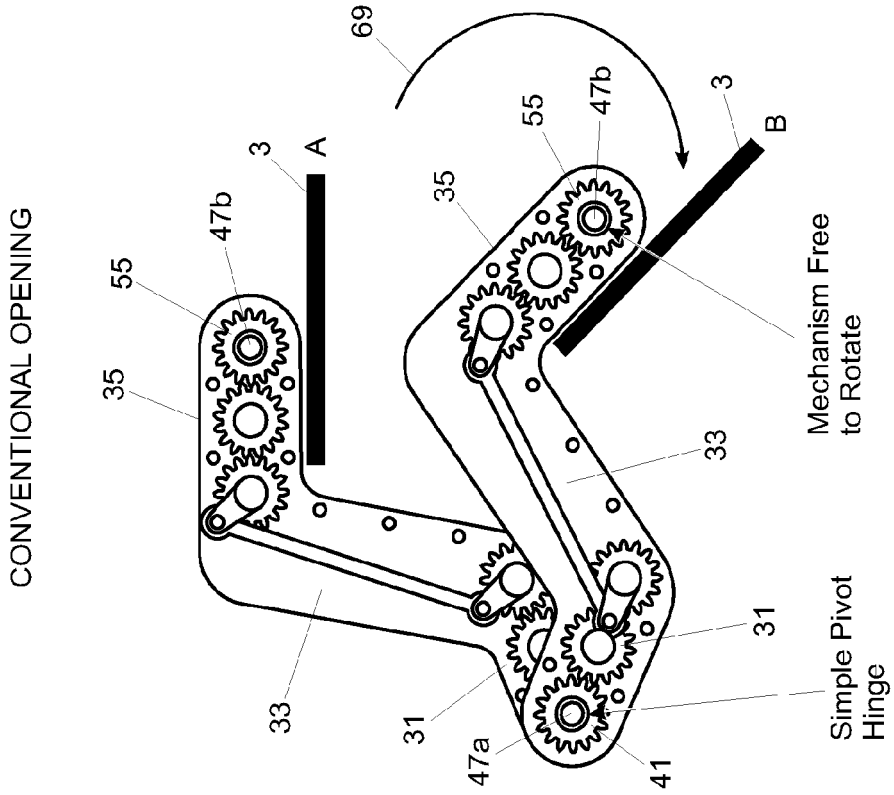

CONVENTIONAL OPENING
A
B
3
47b
55
35
33
31
47a
41
69
Mechanism Free to Rotate
Simple Pivot Hinge

Fig.16

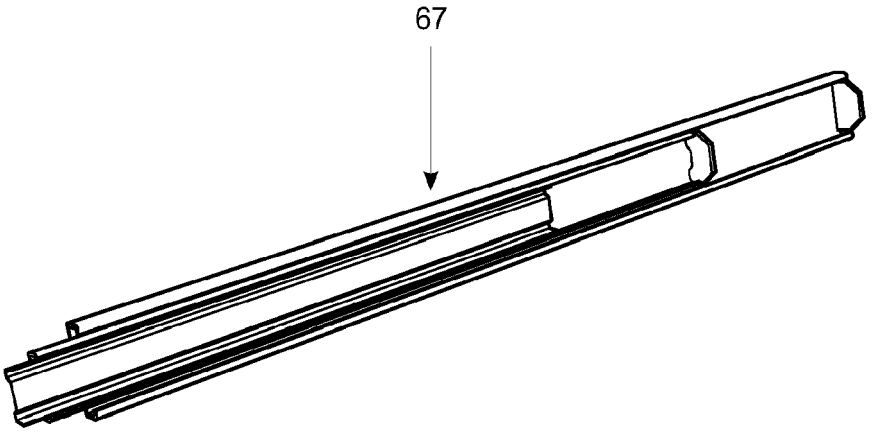


Fig.18

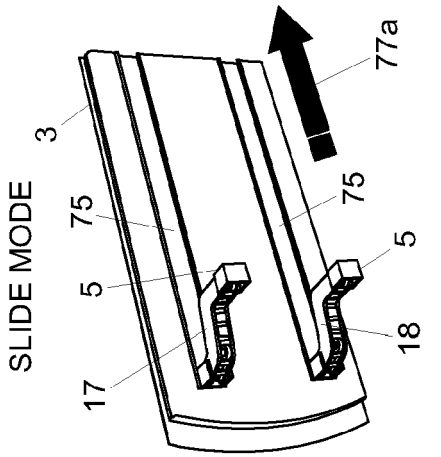


Fig.19(c)

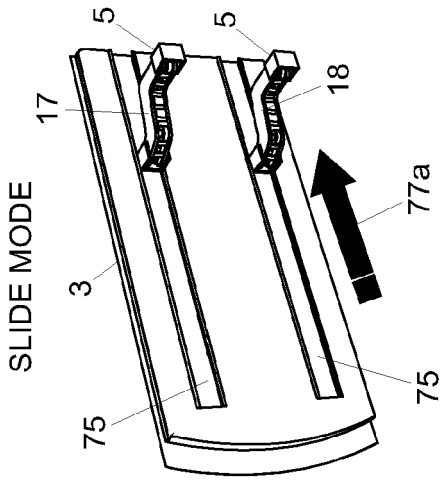


Fig.19(b)

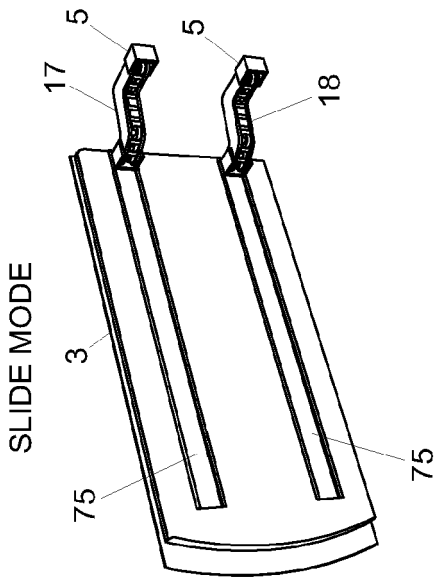


Fig.19(a)

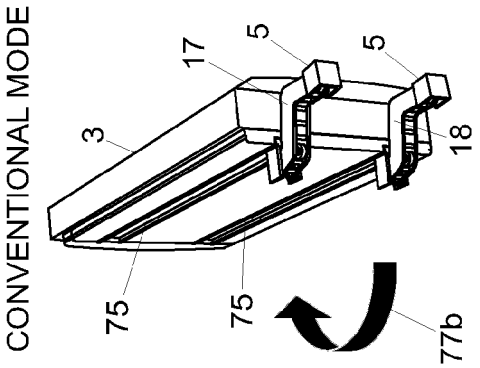


Fig.20(c)

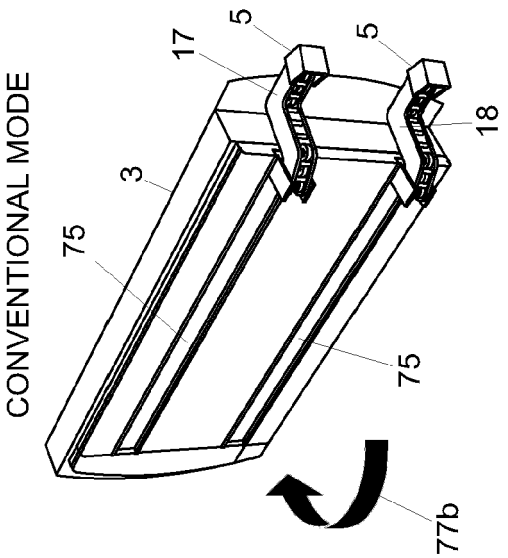


Fig.20(b)

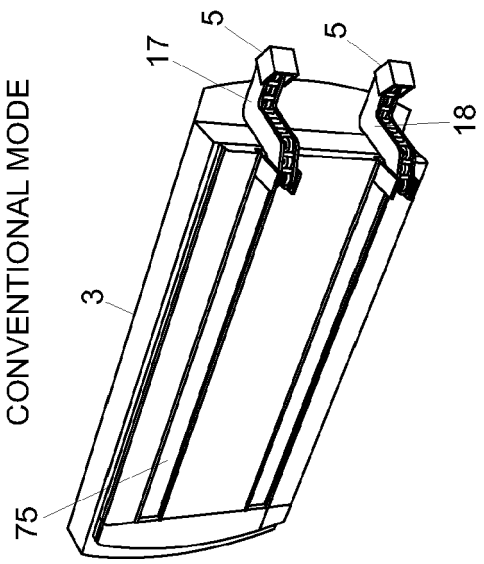


Fig.20(a)

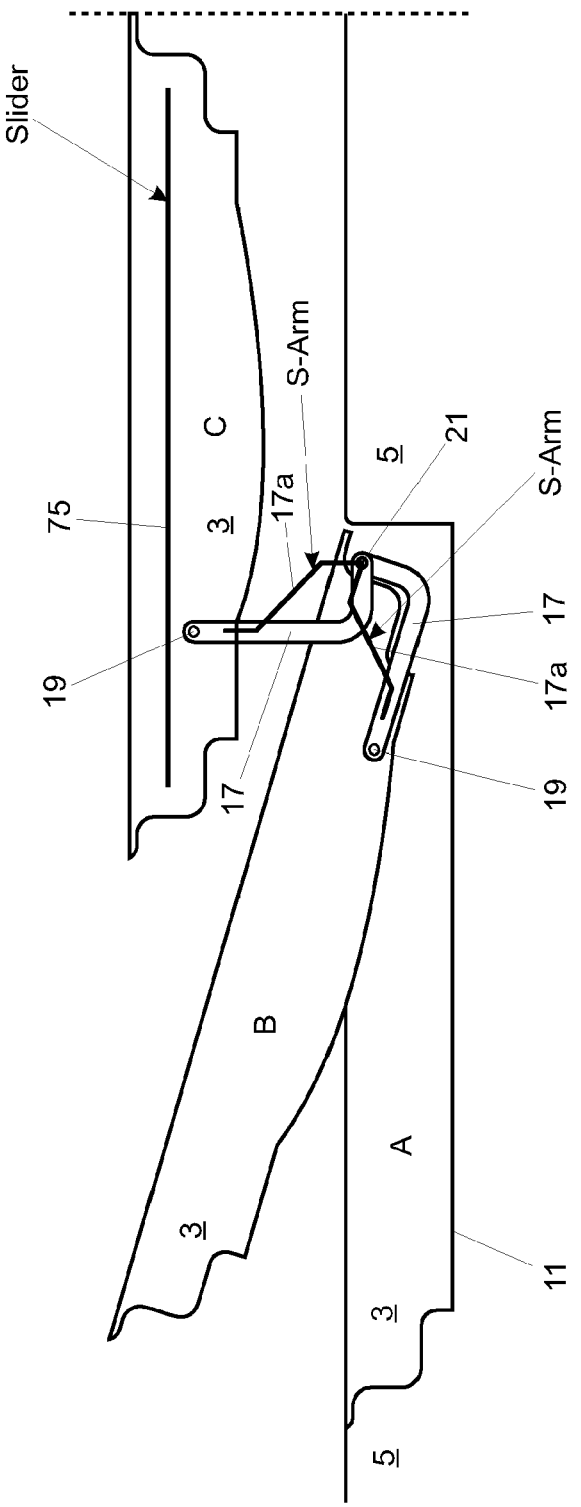


Fig.21

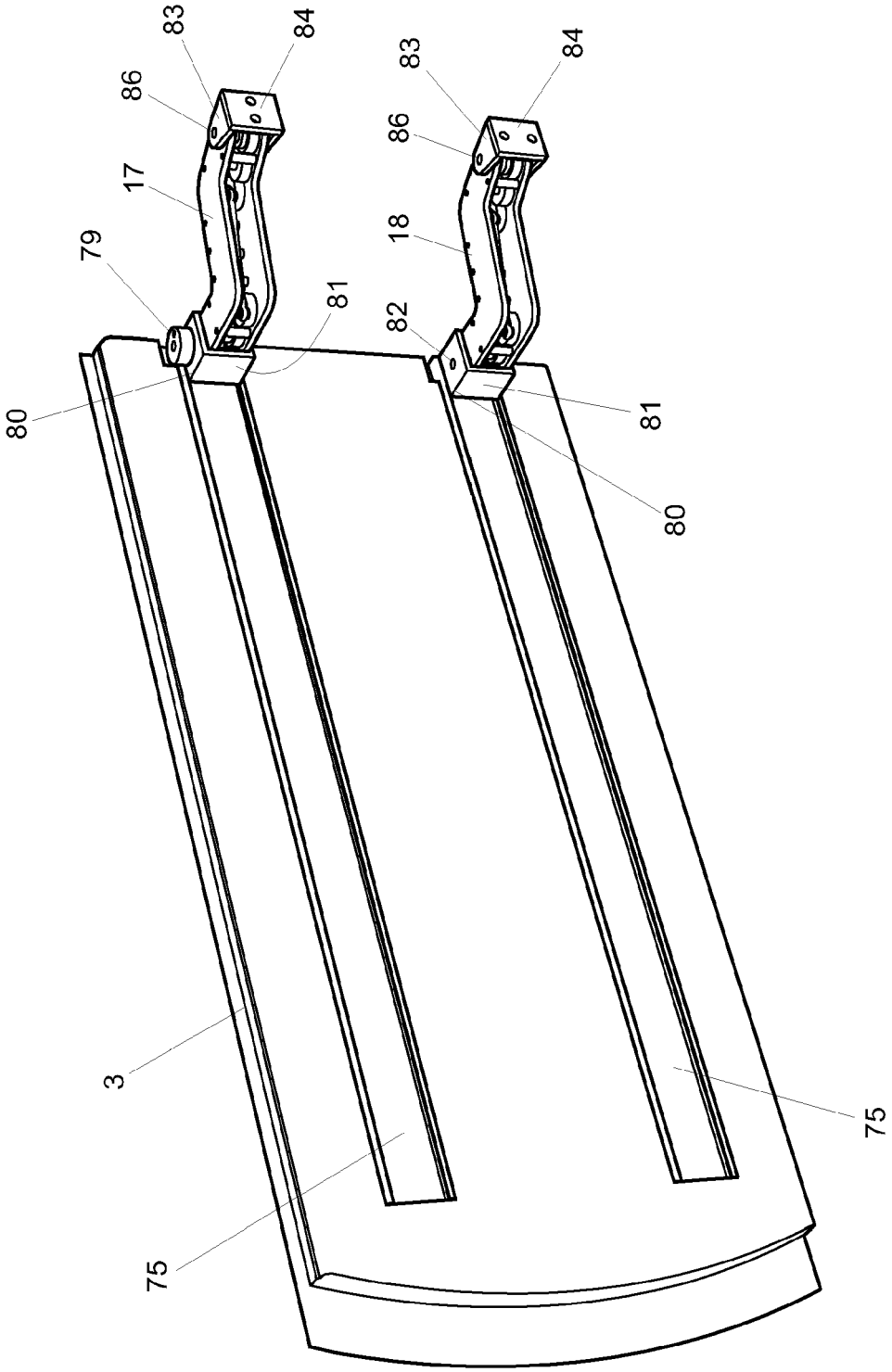


Fig.22

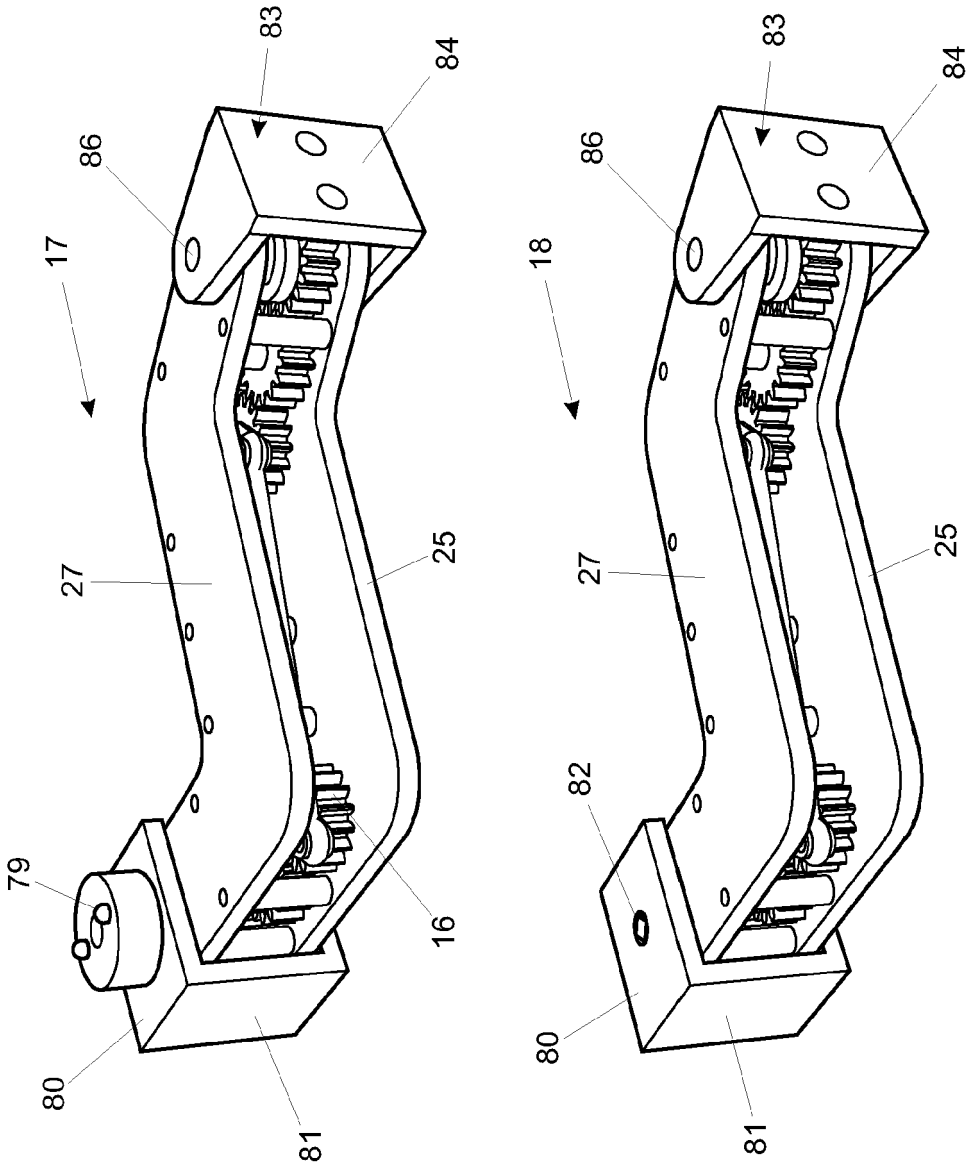


Fig.23

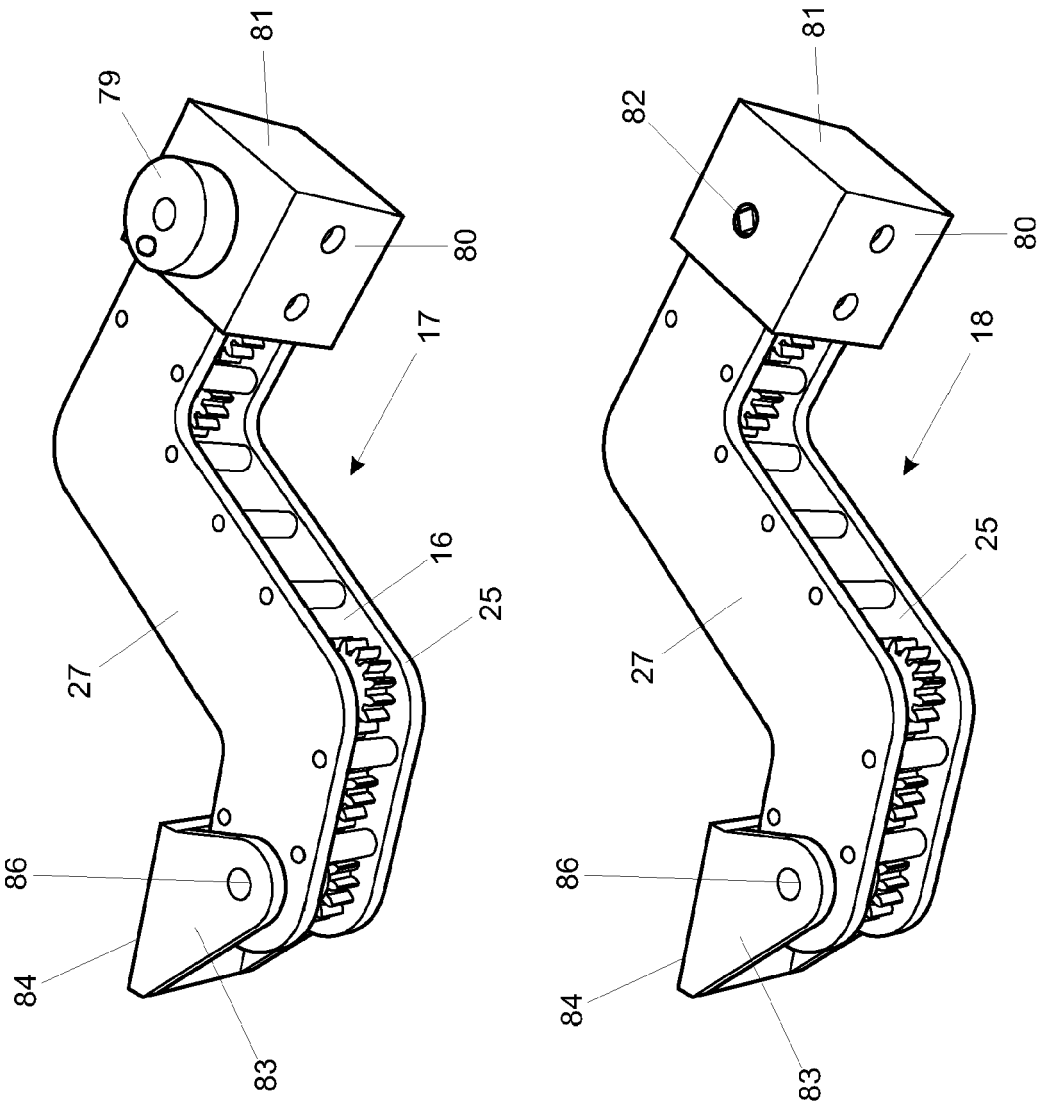
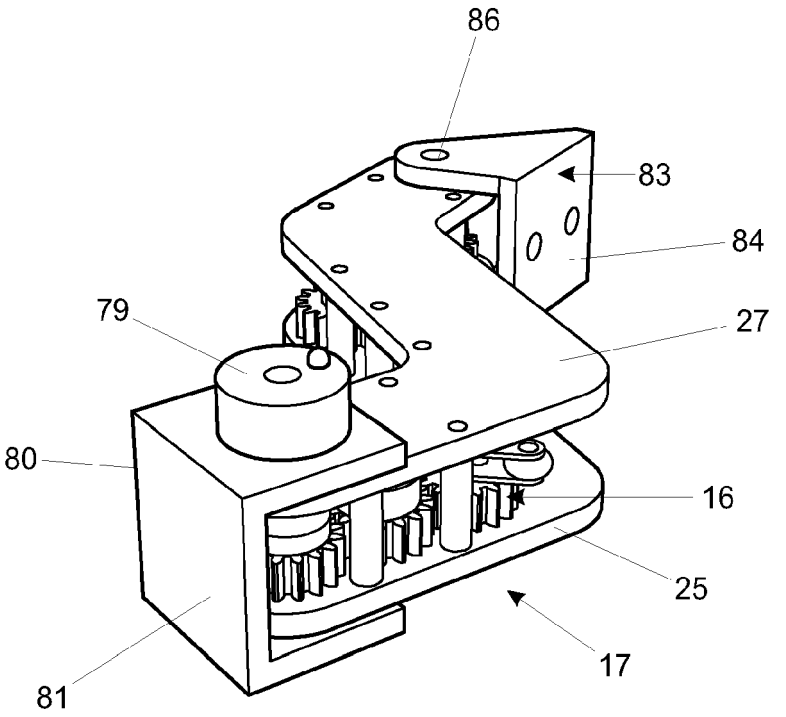


Fig.24



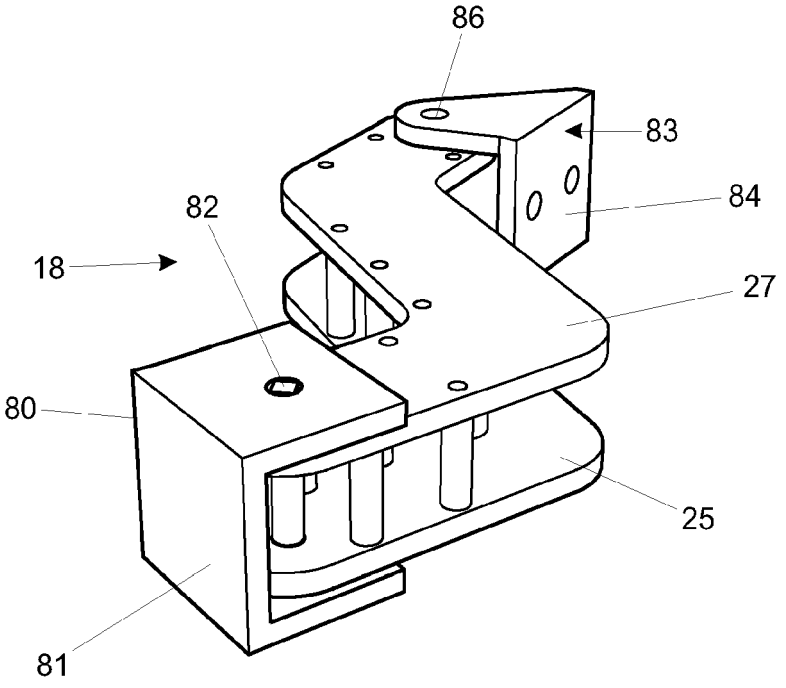


Fig.25

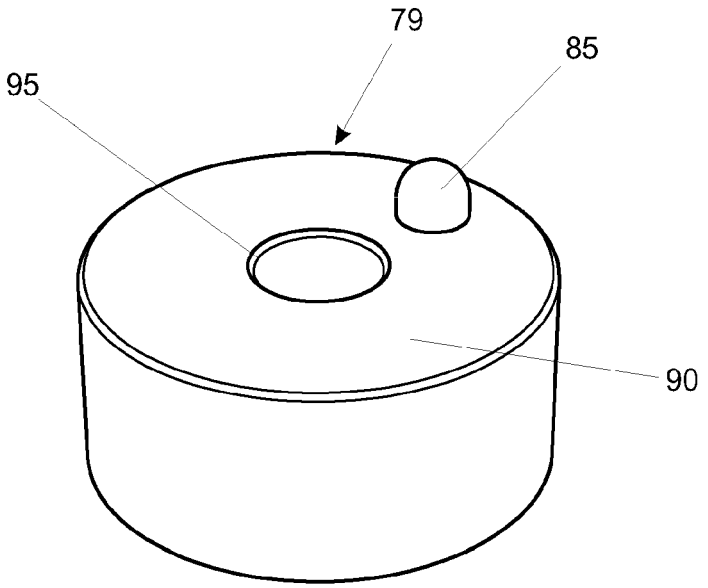


Fig.26(a)

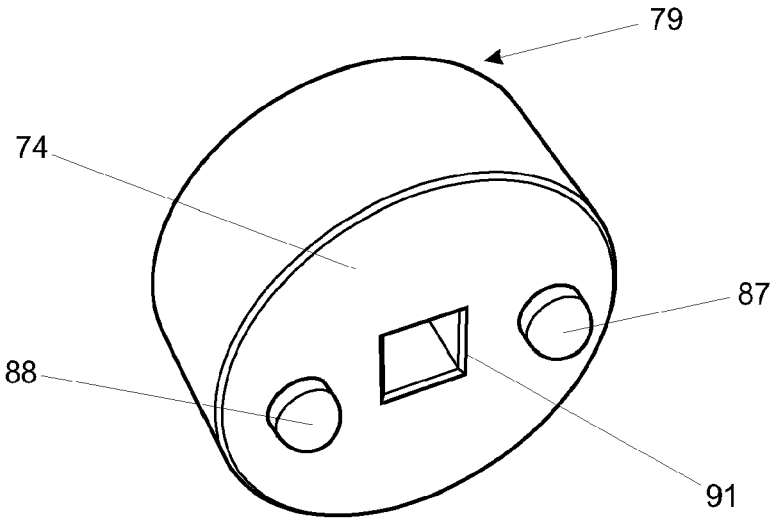


Fig.26(b)

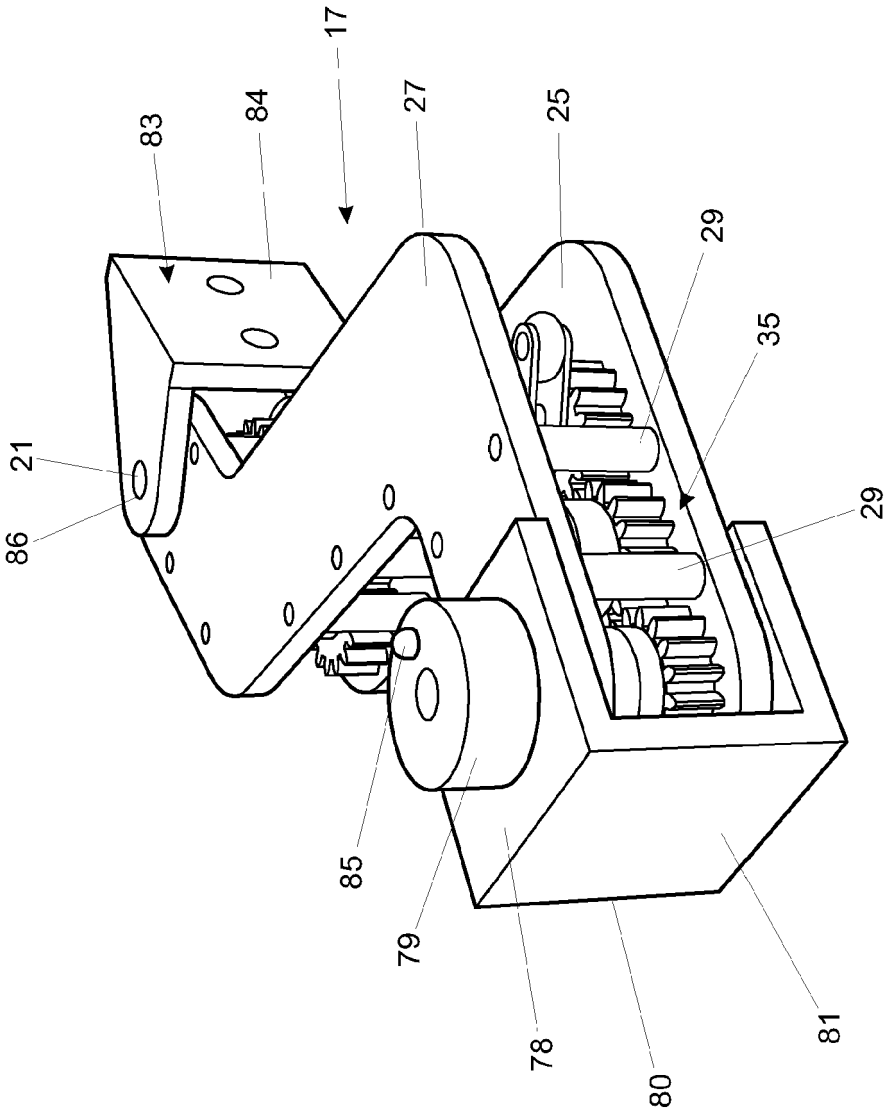


Fig.27

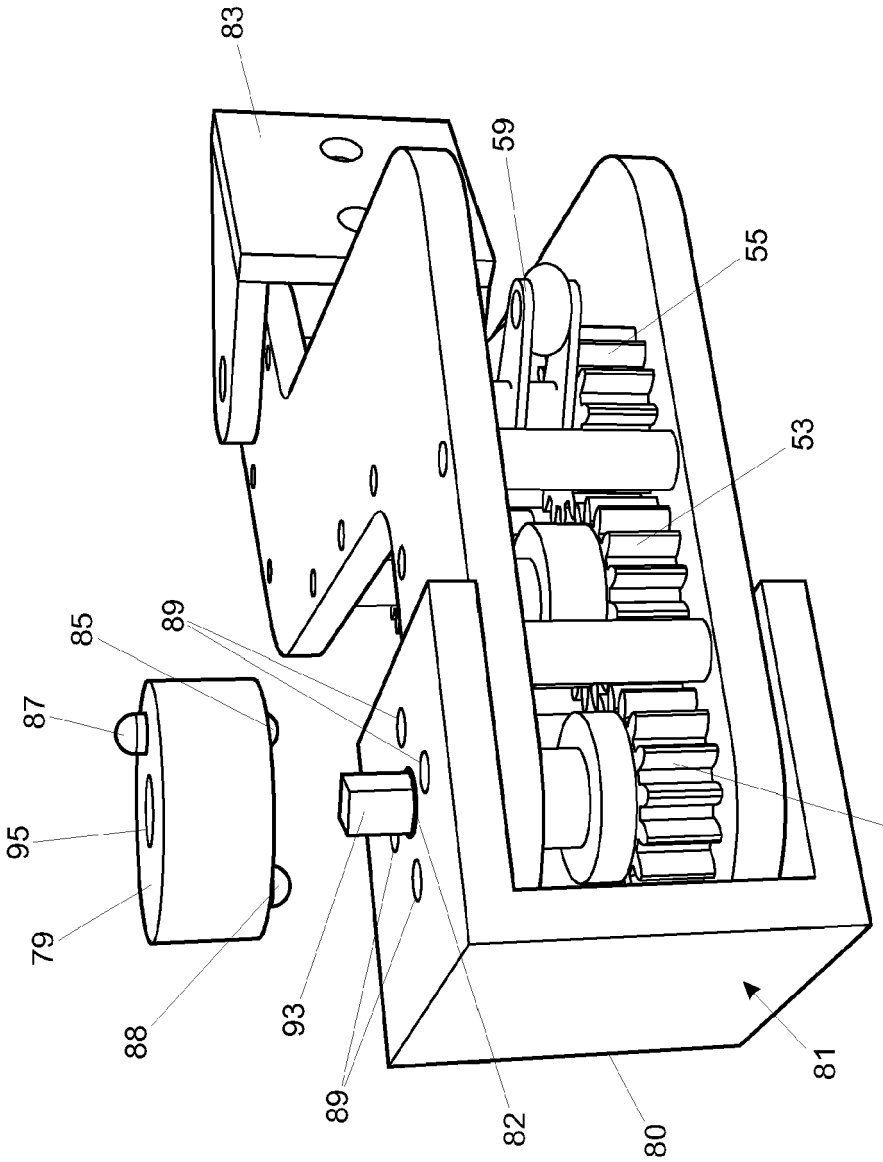


Fig.28

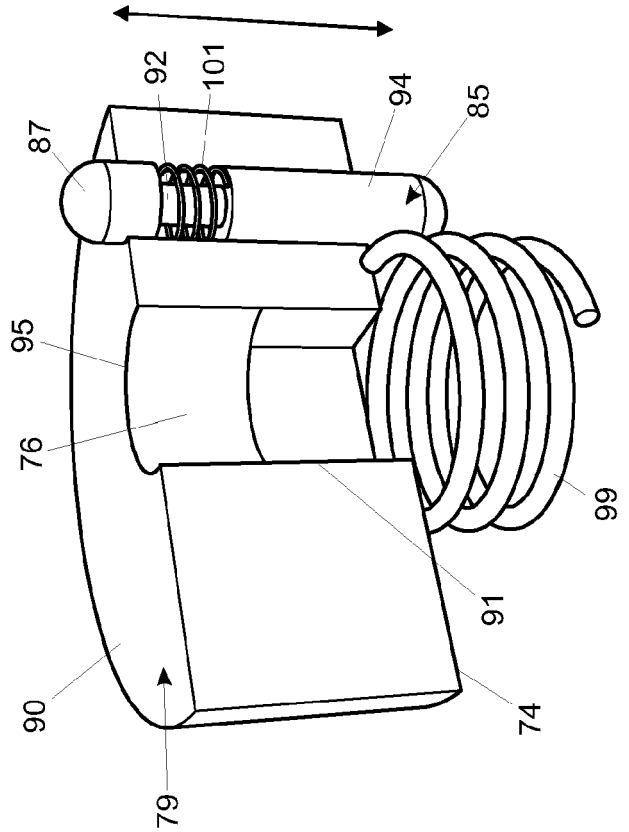


Fig.29(b)

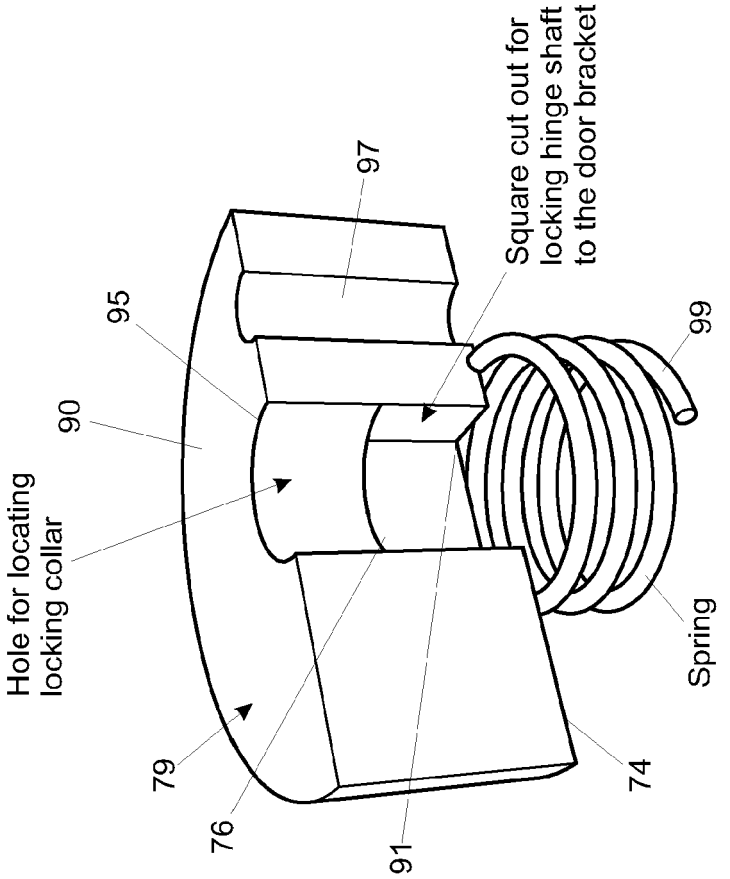


Fig.29(a)

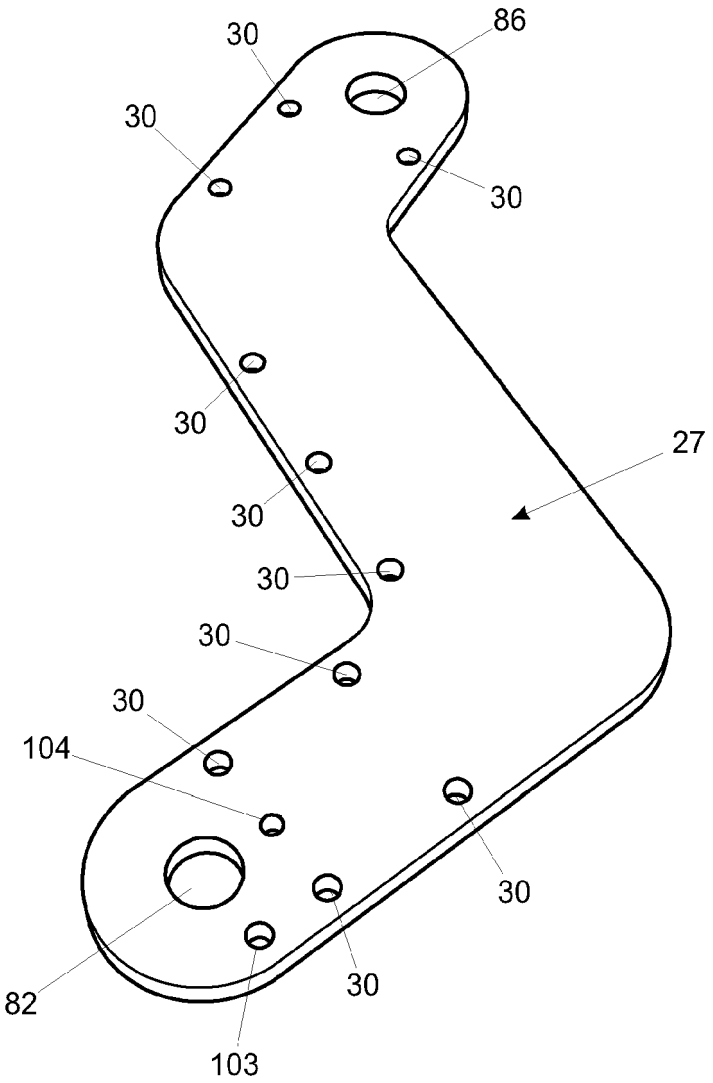


Fig.30

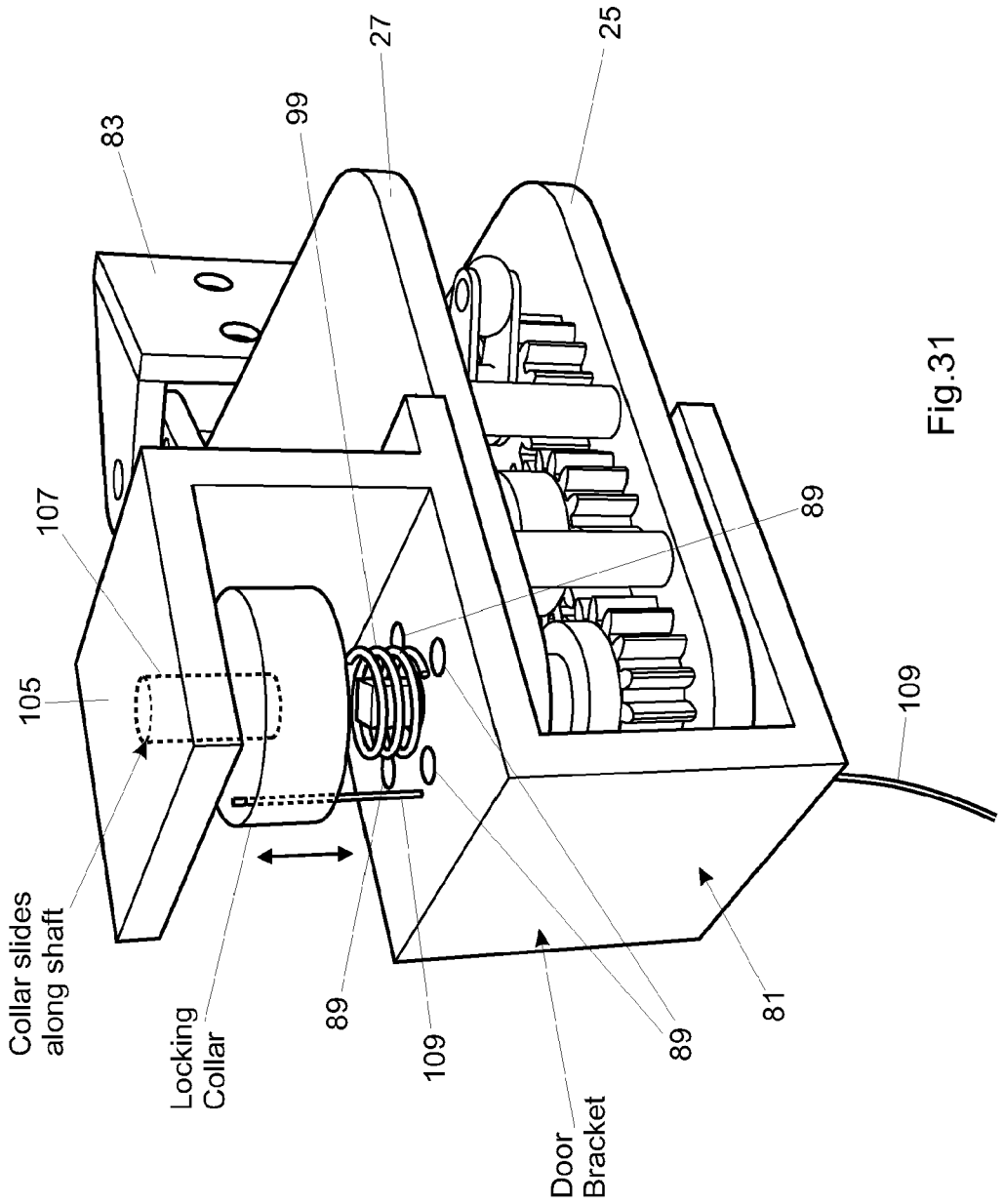

83
99
27
25
107
89
105
109
Collar slides along shaft
Locking Collar
89
109
89
81
Door Bracket

Fig.31

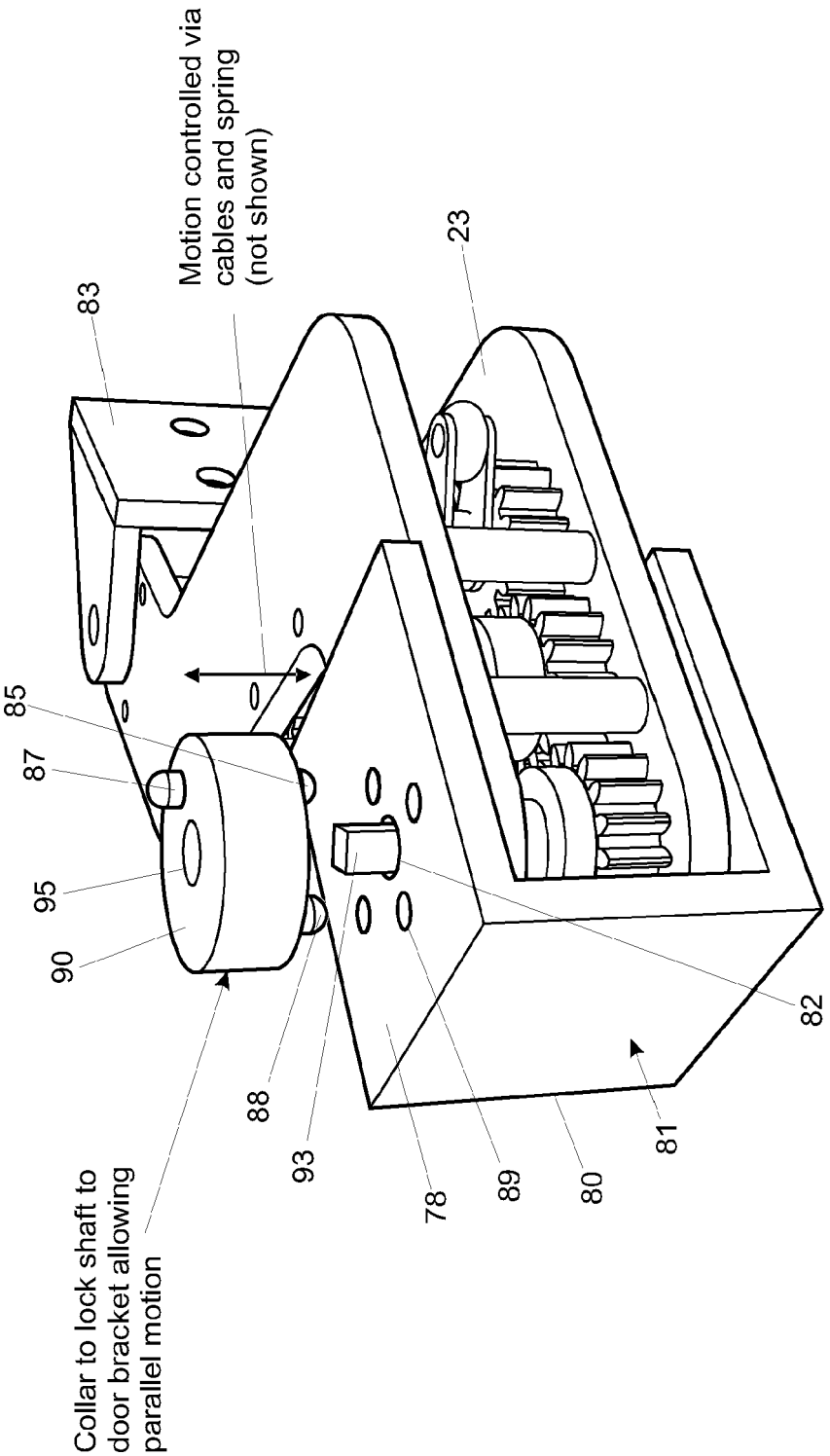

Motion controlled via cables and spring (not shown)
83
23
85
87
95
90
82
88
93
78
89
80
81
Collar to lock shaft to door bracket allowing parallel motion

Fig.32

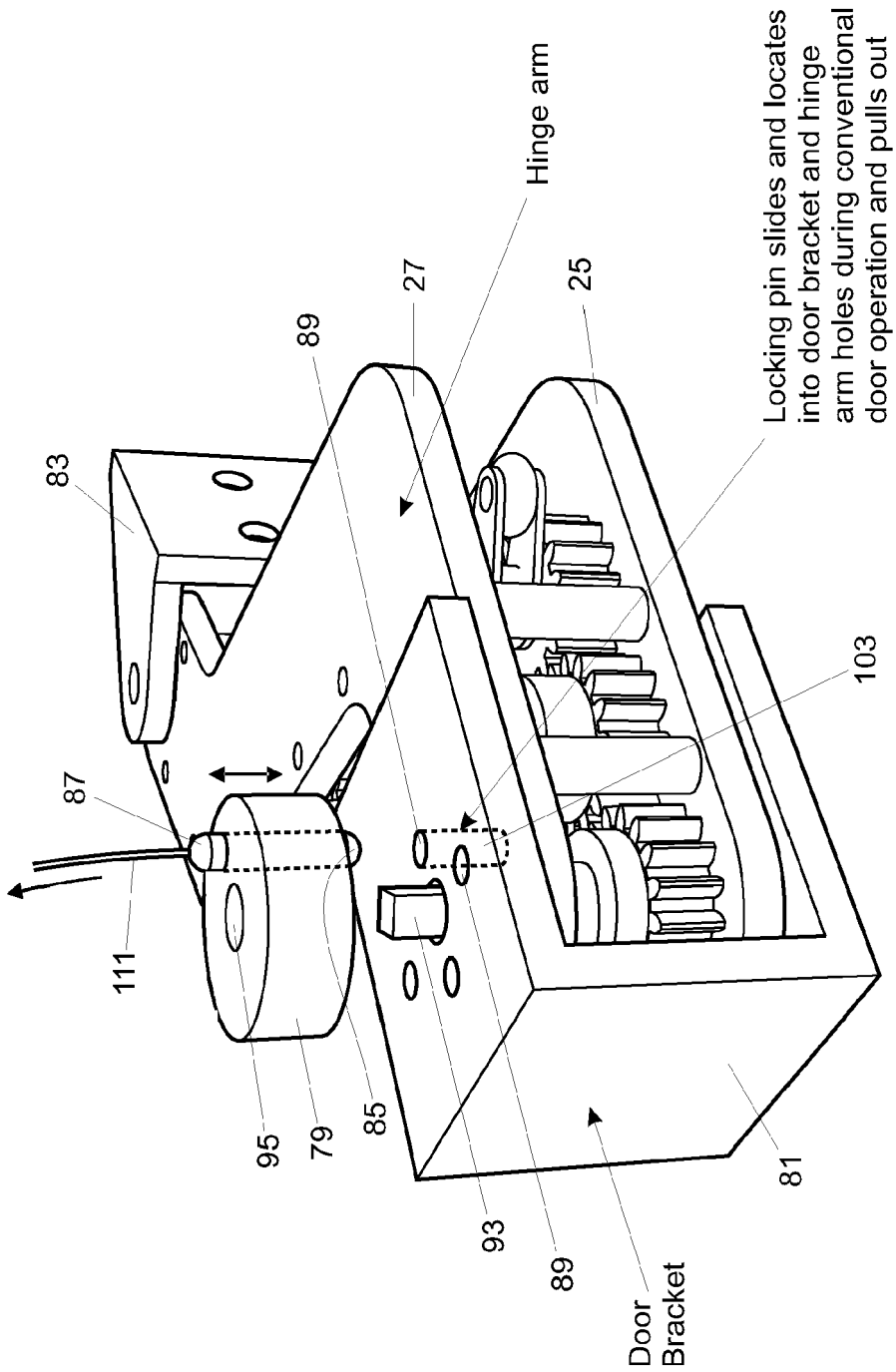

Hinge arm
Locking pin slides and locates into door bracket and hinge arm holes during conventional door operation and pulls out during parallel door motion.
27
25
89
83
87
103
111
95
79
85
93
89
Door Bracket
81

Fig.33

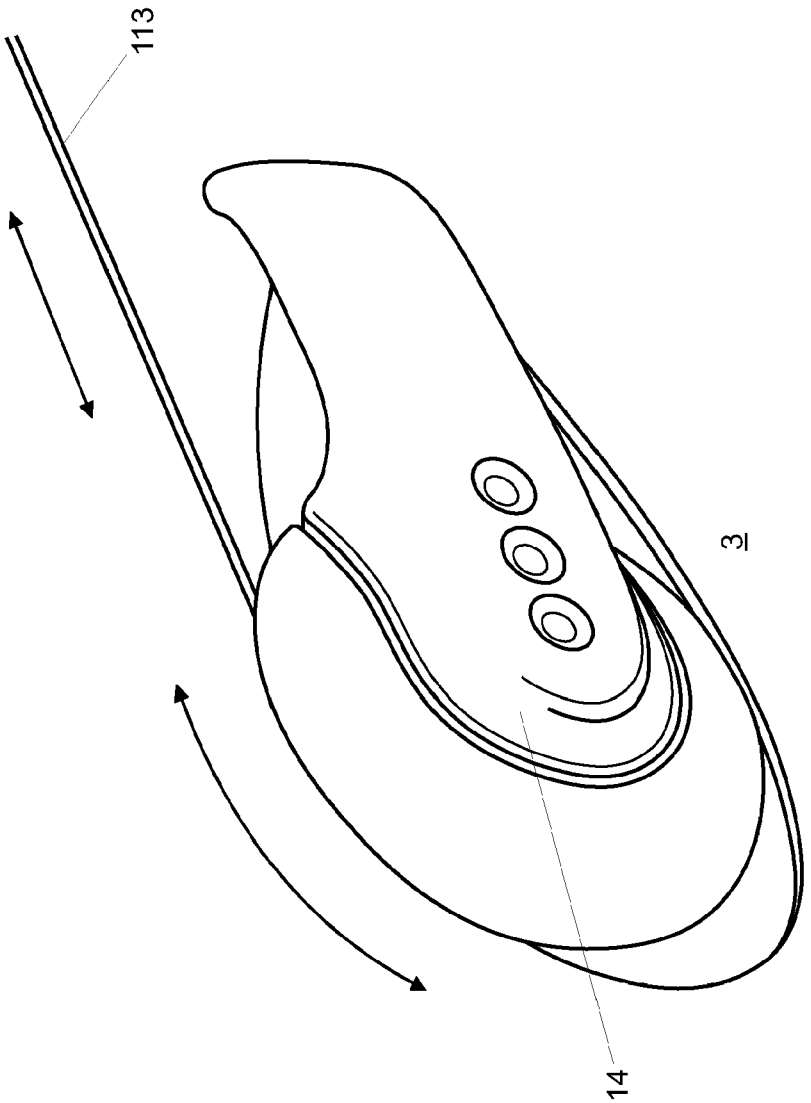


Fig.34

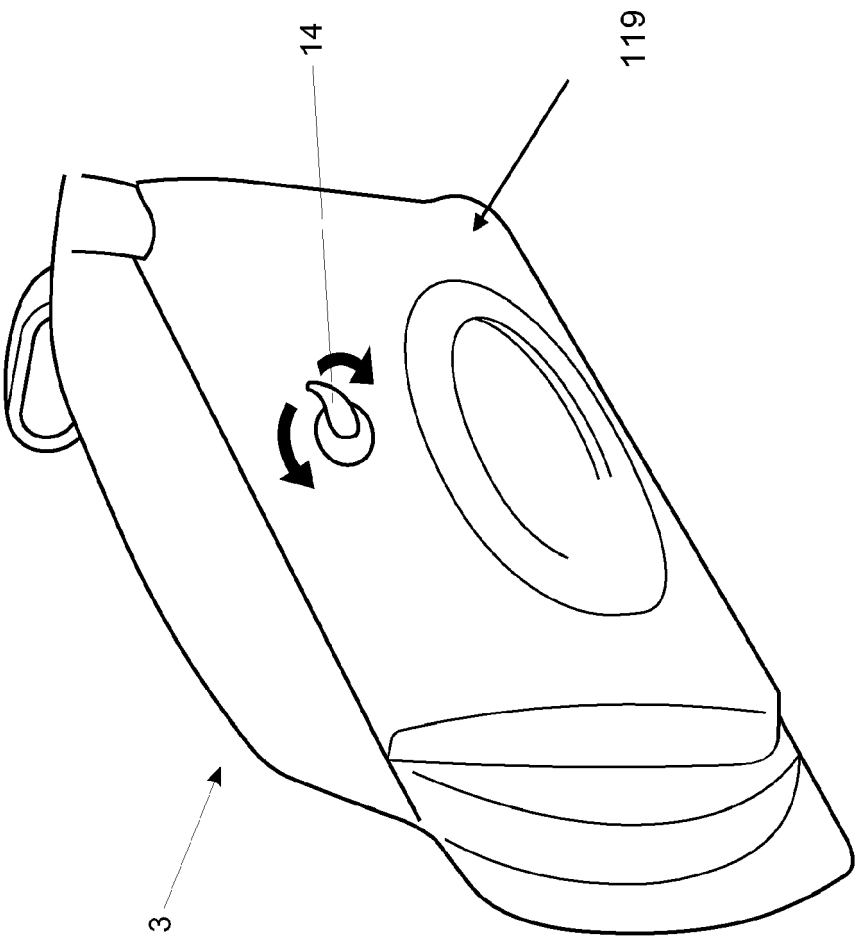


Fig.35

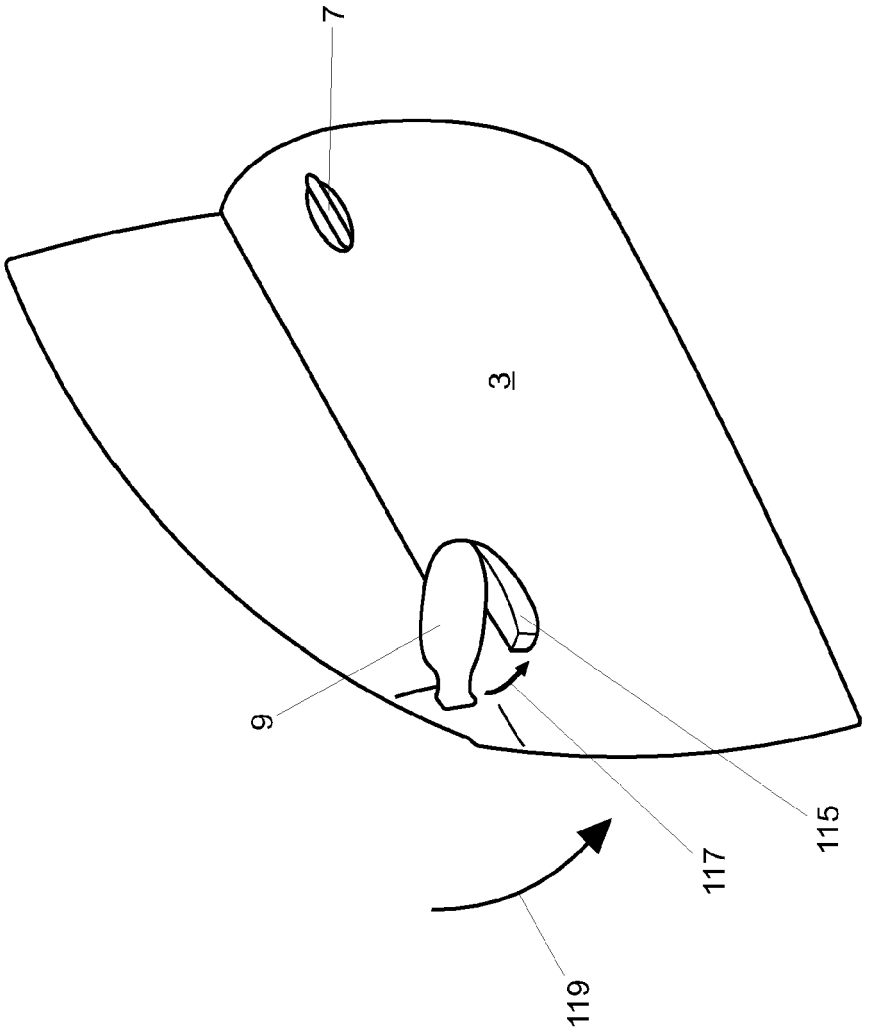


Fig.36

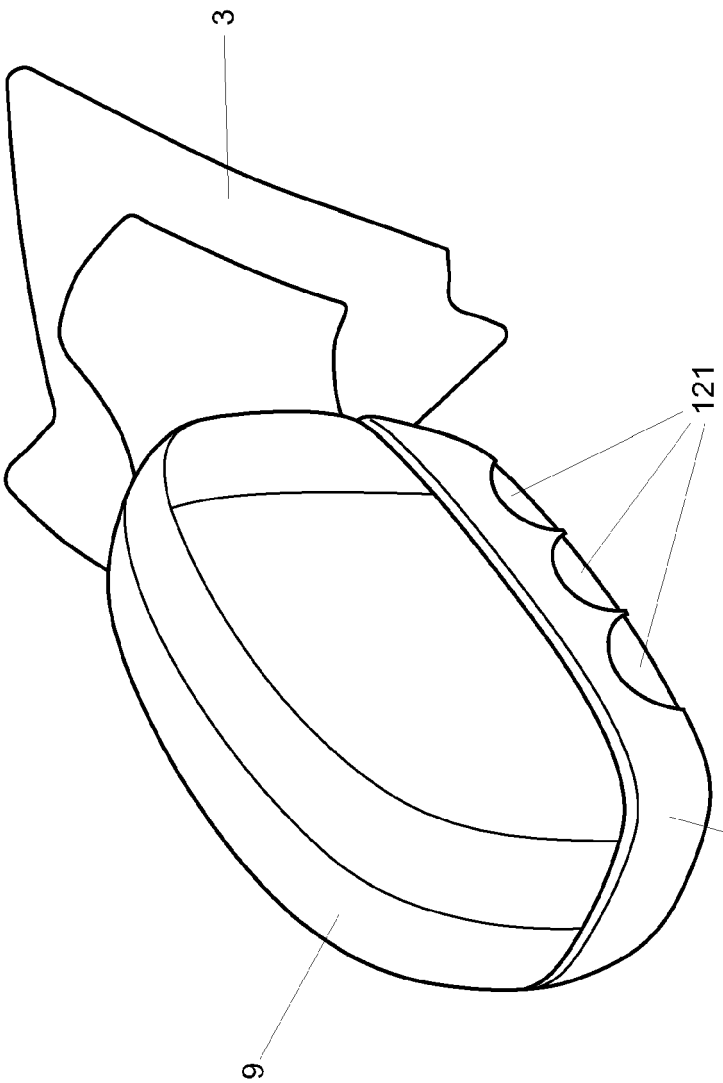


Fig.37

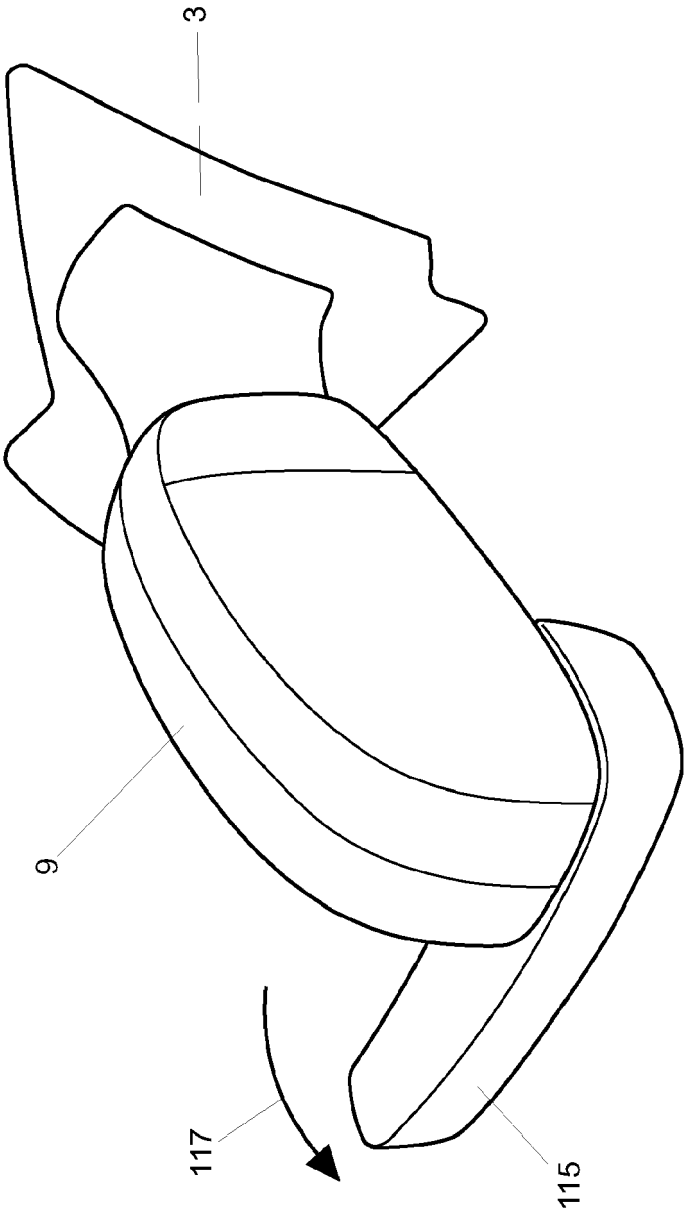


Fig.38