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(54) **Swing arm unit for a side door of a vehicle and a car provided with such a swing arm unit**

(57) A swing arm unit, which is configured to allow a side door of a vehicle to swing outward and rearward with respect to a vehicle body from a closed position to an open position and which comprises:
- a first mounting bracket (10) to be connected to a door pillar of the vehicle;
- a second mounting bracket (20) to be connected to the side door;
- a swing arm (30) extending between said mounting brackets;
- an electric motor (33) for pivoting the swing arm in relation to the first mounting bracket; and
- a reduction gear system (40) acting between the motor and the first mounting bracket.

The motor and the gear system are mounted to the swing arm so as to be carried by and move together with the swing arm when the swing arm is pivoted in relation to the first mounting bracket.

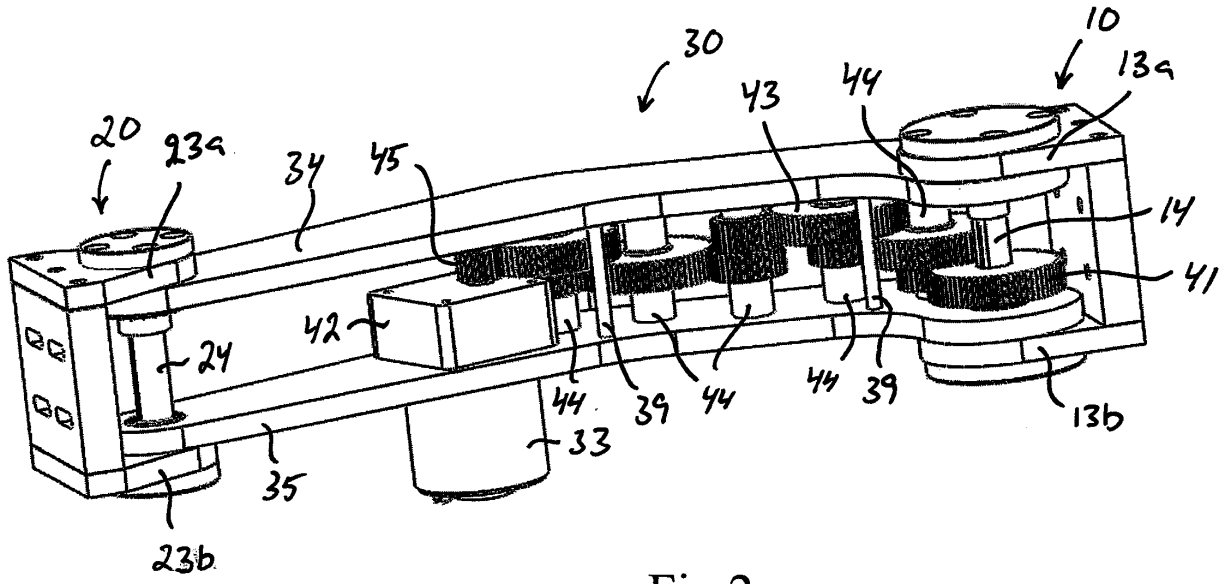

Fig 2

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Description

FIELD OF THE INVENTION AND PRIOR ART

[0001] The present invention relates to a swing arm unit for a side door of a vehicle configured to allow a side door of a vehicle to swing outward and rearward with respect to a vehicle body from a closed position to an open position and in the opposite direction from the open position to the closed position. The invention also relates to a car provided with such a swing arm unit.

[0002] On the respective side of a conventional private car, there is normally a front side door extending between the so called A pillar and B pillar of the car body and a rear side door extending between the B pillar and C pillar of the car body. The front side door is normally hinged to the A pillar so as to swing out forward when being opened, and the rear side door is normally hinged to the B pillar so as to swing out forward when being opened. In order to adapt a conventional private car to the needs of a disabled driver, the conventional hinge of a rear side door of a car is sometimes replaced by a swing arm, which is mounted to the C pillar of the car body so as to allow the rear side door to be opened by moving outward and rearward while remaining essentially in parallel with the adjacent side of the car. Hereby, the rear side door can be completely moved away from the door opening between the B pillar and the C pillar so as to, for instance, make it easier to introduce a wheelchair into the passenger seat through this door opening.

SUMMARY OF THE INVENTION

[0003] The object of the present invention is to provide a new and favourable swing arm unit for a side door of a vehicle.

[0004] According to the invention, this object is achieved by a swing arm unit having the features defined in claim 1.

[0005] The swing arm unit of the invention comprises:

- a first mounting bracket to be connected to a door pillar of a vehicle;
- a second mounting bracket to be connected to a side door of a vehicle;
- a swing arm extending between the first mounting bracket and the second mounting bracket, the swing arm being connected to the first mounting bracket through a first joint so as to be pivotable in relation to the first mounting bracket about a first pivot axis, and the second mounting bracket being connected to the swing arm through a second joint so as to be pivotable in relation to the swing arm about a second pivot axis extending in parallel with said first pivot axis;
- an electric motor for pivoting the swing arm in relation to the first mounting bracket about said first pivot axis; and
- a reduction gear system, which is configured to act between the motor and the first joint and through which the motor is capable of pivoting the swing arm in relation to the first mounting bracket about said first pivot axis.

[0006] The motor and the reduction gear system are mounted to the swing arm so as to be carried by the swing arm and move together with the swing arm when the swing arm is pivoted in relation to the first mounting bracket about said first pivot axis.

[0007] Thus, the actuating means for pivoting the swing arm in relation to the vehicle body, i.e. the electric motor and the reduction gear system, are mounted to and carried by the swing arm itself. Hereby, no actuating means need to be mounted between the mounting bracket and the swing arm or between the vehicle body and the swing arm, which will make the swing arm unit compact and easy to install in a conventional private car and also make it possible to design the swing arm unit in such a manner that a swing arm unit of one and the same configuration may fit conventional cars of various models. Furthermore, the swing arm unit of the invention can be delivered to the customer in a completely pre-assembled state.

[0008] According to an embodiment of the invention:

- the first joint comprises a pivot pin non-rotatably connected to the first mounting bracket;
- the reduction gear system comprises a gear member non-rotatably connected to said pivot pin; and
- the reduction gear system comprises a set of gear wheels acting between the motor and said gear member.

[0009] The use of gear wheels will make it possible to achieve a high gear ratio with a compact design of the reduction gear system.

[0010] According to another embodiment of the invention, the reduction gear system is mounted in an internal space of the swing arm. The swing arm unit of the invention can hereby be given a compact design with a limited number of protruding parts and the gear members of the reduction gear system will be located in a protected manner inside the swing arm.

[0011] Another embodiment of the invention is **characterized in**:

- **that** the first joint comprises a first pivot pin non-rotatably connected to the first mounting bracket;
- that the second joint comprises a second pivot pin non-rotatably connected to the second mounting bracket;
- that a first sprocket wheel is non-rotatably connected to the first pivot pin;
- that a second sprocket wheel is non-rotatably connected to the second pivot pin; and
- that a flexible transmission member in the form of a

sprocket chain or belt runs about said first and second sprocket wheels and is operably connected to them so as to make the second mounting bracket pivot in relation to the swing arm about said second pivot axis when the swing arm is pivoted in relation to the first mounting bracket about said first pivot axis.

[0012] Hereby, the pivoting of the swing arm in relation to the first mounting bracket and the pivoting of the second mounting bracket in relation to the swing arm can be achieved by means of one and the same motor, and the sprocket wheels can easily be adapted so as to control the pivoting of the second mounting bracket in such a manner that a side door mounted to the second mounting bracket will remain essentially in parallel with the side of the vehicle when the side door is opened and closed by means of the swing arm unit.

[0013] According to another embodiment of the invention, the flexible transmission member is located in an internal space of the swing arm. Hereby, the flexible transmission member will be located in a protected manner inside the swing arm.

[0014] According to another embodiment of the invention, the first sprocket wheel has a larger diameter than the second sprocket wheel. Hereby, the swing arm unit can be designed to move a rear side door of a car in such a manner between an open position essentially in parallel to the car body and a closed position that the rear side door will first hit the B pillar of the car body with its front edge so as to thereafter swing in relation to the B pillar until its rear edge comes into engagement with the C pillar of the car body. During the final part of the closing movement, the rear side door will consequently move in essentially the same manner as a corresponding rear side door conventionally hinged to the B pillar, which will allow the rear side door to co-operate properly with the front side door and the door pillars when the conventional hinge of the rear side door is replaced by the swing arm unit of the invention.

[0015] Another embodiment of the invention is **characterized in**:

- **that** the swing arm has a first side, which is intended to face away from the side door when the side door is in the closed position, and an opposite second side, which is intended to face the side door when the side door is in the closed position;
- that the transmission member extends between the first and second sprocket wheels in a first path facing said first side of the swing arm and in a second path facing said second side of the swing arm; and
- that the part of the transmission member extending along said first path is elastically extendable against the action of a spring force.

[0016] Hereby, the transmission member will be pretensioned during the above-mentioned final part of the closing movement when the rear side door swings in relation to the B pillar until its rear edge comes into engagement with the C pillar. The transmission member will remain pretensioned as long as the latch of the side door is engaged, and when the latch is released the rear edge of the side door will be forced a short distance outwards away from the C pillar under the effect of the pretensioning force in the transmission member. This will facilitate the opening of the door.

[0017] Further advantages as well as advantageous features of the swing arm unit according to the invention will appear from the following description and the dependent claims.

[0018] The invention also relates to a car having the features defined in claim 10.

BRIEF DESCRIPTION OF THE DRAWING

[0019] With reference to the appended drawing, a specific description of preferred embodiments of the invention cited as examples follows below. In the drawings:

Fig 1	is a perspective view of a swing arm unit according to an embodiment of the present invention,
Fig 2	is a perspective view of the swing arm unit of Fig 1 with a side wall removed,
Fig 3	is a lateral view of the swing arm unit of Fig 1 with a side wall removed,
Fig 4	is a cut planar view from above of the swing arm unit of Fig 1,
Fig 5	is a sectional view illustrating a first joint included in the swing arm unit of Fig 1,
Fig 6	is a sectional view illustrating a second joint included in the swing arm unit of Fig 1, and
Fig 7a-7c	are schematic views illustrating different stages during the movement of a rear side door of a car from an open position to a closed position by means of the swing arm unit of Fig 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0020] Fig 1 illustrates a swing arm unit 1 according to an embodiment of the present invention. The swing arm unit 1 is to be mounted to a motor vehicle, for instance in the form of a private car of conventional type, in order to carry a side door of the vehicle. The swing arm unit 1 is intended to replace the conventional hinge of the side door 2 and is configured to allow the side door to swing outward and rearward with respect to the vehicle body 3

from a closed position (see Fig 7c) to an open position (see Fig 7a) and in the opposite direction from the open position to the closed position, while allowing the side door 2 to be positioned essentially in parallel with the adjacent side of the vehicle body 3 when the side door is in the open position.

[0021] The swing arm unit 1 comprises a first mounting bracket 10, which is to be connected to a door pillar 4 (see Fig 4 and Figs7a-7c) of a vehicle, and a second mounting bracket 20, which is to be connected to a side door 2 of the vehicle. A swing arm 30 extends between the first mounting bracket 10 and the second mounting bracket 20. The swing arm 30 is connected to the first mounting bracket 10 through a first joint 11 so as to be pivotable in relation to the first mounting bracket 10 about a vertical first pivot axis A1, whereas the second mounting bracket 20 is connected to the swing arm 30 through a second joint 21 so as to be pivotable in relation to the swing arm 30 about a vertical second pivot axis A2, which extends in parallel with said first pivot axis A1.

[0022] In the illustrated embodiment, the swing arm 30 has a curved shape as seen in a planar view, with an essentially convex first side 31, which is intended to face away from the side door 2 when the side door is in the closed position (see Fig 7c), and an essentially concave second side 32, which is located opposite said first side 31 and intended to face the side door 2 when the side door is in the closed position.

[0023] In the illustrated embodiment, the first mounting bracket 10 comprises a mounting plate 12, which is to be secured to a door pillar 4 of a vehicle. An upper arm 13a and a lower arm 13b are secured to the mounting plate 12 and extend therefrom in the direction towards the swing arm 30. The second mounting bracket 20 comprises a mounting plate 22, which is to be secured to a side door 2 of a vehicle. An upper arm 23a and a lower arm 23b are secured to the mounting plate 22 and extend therefrom in the direction towards the swing arm 30. The swing arm 30 is at one end received between the arms 13a, 13b of the first mounting bracket and at the other end received between the arms 23a, 23b of the second mounting bracket.

[0024] The first joint 11 comprises a pivot pin 14, here denominated first pivot pin, which is non-rotatably connected to the first mounting bracket 10 and extends between the arms 13a, 13b thereof. An upper end plate 15a is non-rotatably secured to the first pivot pin 14 at the upper end thereof and a lower end plate 15b is non-rotatably secured to the first pivot pin 14 at the lower end thereof. The upper end plate 15a is secured to the upper arm 13a of the first mounting bracket, and the lower end plate 15b is secured to the lower arm 13b of the first mounting bracket. The second joint 21 comprises a pivot pin 24, here denominated second pivot pin, which is non-rotatably connected to the second mounting bracket 20 and extends between the arms 23a, 23b thereof. An upper end plate 25a is non-rotatably secured to the second pivot pin 24 at the upper end thereof and a lower end plate 25b is non-rotatably secured to the first pivot pin 24 at the lower end thereof. The upper end plate 25a is secured to the upper arm 23a of the second mounting bracket, and the lower end plate 25b is secured to the lower arm 23b of the second mounting bracket. In the illustrated embodiment, the respective end plate 15a, 15b, 25a, 25b is secured to the associated mounting bracket arm 13a, 13b, 23a, 23b by means of fastening members 16, 26 in the form of screws.

[0025] At its inner end, the swing arm 30 is pivotally mounted to the first pivot pin 14 by means of suitable bearings 17, as illustrated in Fig 5. At its outer end, the swing arm 30 is pivotally mounted to the second pivot pin 24 by means of suitable bearings 27, as illustrated in Fig 6.

[0026] The swing arm unit 1 comprises an electric motor 33 for pivoting the swing arm 30 in relation to the first mounting bracket 10 about the first pivot axis A1. The swing arm unit 1 also comprises a reduction gear system 40, which is configured to act between the motor 33 and the first joint 11 and through which the motor 33 is capable of pivoting the swing arm 30 in relation to the first mounting bracket 10 about the first pivot axis A1. The reduction gear system 40 is configured to effect a gear reduction between the output shaft of the motor 33 and the first joint 11. The motor 33 and the gear system 40 are mounted to the swing arm 30 so as to be carried by the swing arm and move together with the swing arm when the swing arm is pivoted in relation to the first mounting bracket 10 about the first pivot axis A1. Thus, the actuating means, i.e. the motor 33 and the gear system 40, for pivoting the swing arm 30 in relation to the vehicle body are mounted to and move together with the swing arm.

[0027] In the illustrated embodiment, the swing arm 30 comprises a top plate 34 and a bottom plate 35 arranged at a distance from and in parallel with each other. Side walls 36 are arranged between the top plate 34 and the bottom plate 35 along the edges thereof so as to enclose an internal space inside the swing arm. In the illustrated example, the motor 33 is secured to the bottom plate 35 on the underside thereof, whereas the gear system 40 is mounted in the internal space of the swing arm 30 formed between the top plate 34, the bottom plate 35 and the side walls 36.

[0028] The gear system 40 comprises a gear member 41 which is non-rotatably connected to the first pivot pin 14, and a set of gear wheels acting between the motor 33 and said gear member 41. In the illustrated embodiment, said set of gear wheels comprises a first group of gear wheels arranged in a gear box 42 which is attached to the output shaft of the motor, and a second group of gear wheels 43 mounted to shafts 44 which extend between the top plate 34 and the bottom plate 35 of the swing arm. Some of the shafts 44 are provided with a pair of gear wheels 43 of different diameters, the two gear wheels of the pair being connected to each other so as to rotate together. The gear wheels 43 are suitably rotatably mounted to the shafts 44 and the shafts 44 non-

rotatably mounted to the top and bottom plates 34, 35. As an alternative, the gear wheels 43 may be non-rotatably mounted to the shafts 44 and the shafts 44 rotatably mounted to the top and bottom plates 34, 35. Said second group of gear wheels 43 are operably connected to the gear box 42 through a gear wheel 45 which is non-rotatably mounted to the output shaft 46 of the gear box.

[0029] One of the gear wheels 43 is suitably displaceable axially or radially out of engagement with the adjacent gear wheels so as to make it possible to operably disconnect the motor 33 and the gear member 41 from each other when there is a need to pivot the swing arm 30 manually in relation to the first mounting bracket 10. In this case, a manually manoeuvrable operating member (not shown) is provided on the swing arm 30 in order to make possible a movement of said displaceable gear wheel between an engaged position and a disengaged position.

[0030] A first sprocket wheel 18 is non-rotatably mounted to the first pivot pin 14, and a second sprocket wheel 28 is non-rotatably mounted to the second pivot pin 24. An elongated flexible transmission member 37 in the form of a sprocket chain or belt runs about said first and second sprocket wheels 18, 28 and is operably connected to them so as to make the second mounting bracket 20 pivot in relation to the swing arm 30 about the second pivot axis A2 when the swing arm 30 is pivoted in relation to the first mounting bracket 10 about the first pivot axis A1. Thus, a pivoting of the swing arm 30 in relation the first mounting bracket 10 under the effect of the motor 33 and the gear system 40 will also cause a pivoting of the second mounting bracket 20 in relation to the swing arm 30 under the effect of the sprocket wheels 18, 28 and the transmission member 37. The control arrangement formed by the sprocket wheels 18, 28 and the transmission member 37 will consequently control the inclination of the side door 2 in relation to the swing arm 30 and the vehicle body 3 when the side door is moved in either direction between its open position and closed position by means of the swing arm unit 1. The sprocket wheels 18, 28 and the flexible transmission member 37 are located in the internal space of the swing arm 30 formed between the top plate 34, the bottom plate 35 and the side walls 36. The sprocket wheels 18, 28 and the transmission member 37 are with advantage located closely under the top plate 34 of the swing arm 30, as illustrated in Fig 3. The transmission member 37 extends between the first and second sprocket wheels 18, 28 in a first path P1 (see Fig 4) facing the convex first side 31 of the swing arm and in a second path P2 facing the concave second side 32 of the swing arm. The transmission member 37 is guided along said first and second paths P1, P2 by means of guide pins 39, which extend between the top plate 34 and the bottom plate 35 of the swing arm.

[0031] In order to make the side door 2 move in the manner illustrated in Figs 7a-7c, the first sprocket wheel 18 has a larger diameter than the second sprocket wheel 28. In the example illustrated in Fig 7a-7c, the swing arm unit 1 is designed to move the side door 2 in such a manner that the side door 2 extends essentially in parallel with the car body 3 when it is in the open position, as illustrated in Fig 7a. When the swing arm 30 pivots the side door 2 towards its closed position, the sprocket wheels 18, 28 and the transmission member 37 will make the side door 2 pivot about the second pivot axis A2 in such a manner that the front end 2a of the side door will be inclined inwards towards the vehicle body 3. Hereby, the side door 2 will first hit the B pillar 5 of the vehicle body with its front end 2a, as illustrated in Fig 7b, whereupon the side door 2 will swing in relation to the B pillar 5 until its rear end 2b comes into engagement with the C pillar 4 of the vehicle body, as illustrated in Fig 7c. The side door 2 will move in the opposite manner during a movement from the closed position illustrated in Fig 7c to the open position illustrated in Fig 7a. In order to allow the swing arm 30 to pivot from the position illustrated in Fig 7b to the position illustrated in Fig 7c, the part P1 of the transmission member 37 extending along the convex first side 31 of the swing arm is elastically extendable against the action of a spring force. This spring force may for instance be achieved by means of a spring member 38 in the form of a tension spring mounted between two ends of the transmission member 37, as illustrated in Fig 4. The spring member 38 will be pretensioned when the side door 2 swings in relation to the B pillar 5 under the effect of the swing arm 30 from the position illustrated in Fig 7b to the position illustrated in Fig 7c. The spring member 38 will remain pretensioned as long as the side door 2 remains in the closed position illustrated in Fig 7c with the latch of the side door engaged. When the latch of the side door 2 is released, the side door 2 will swing outward in relation to the B pillar 5 under the effect of the pretensioning force in the spring member 38 and the rear end 2b of the side door will thereby be forced a short distance outwards away from the C pillar 4. This will facilitate the opening of the side door 2.

[0032] The invention is of course not in any way restricted to the embodiments described above. On the contrary, many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention such as defined in the appended claims.

Claims

1. A swing arm unit for a side door of a vehicle configured to allow a side door of a vehicle to swing outward and rearward with respect to a vehicle body from a closed position to an open position and in the opposite direction from the open position to the closed position, the swing arm unit (1) comprising:

    - a first mounting bracket (10) to be connected to a door pillar of a vehicle,

- a second mounting bracket (20) to be connected to a side door of a vehicle,
- a swing arm (30) extending between the first mounting bracket (10) and the second mounting bracket (20), the swing arm (30) being connected to the first mounting bracket (10) through a first joint (11) so as to be pivotable in relation to the first mounting bracket (10) about a first pivot axis (A1), and the second mounting bracket (20) being connected to the swing arm (30) through a second joint (21) so as to be pivotable in relation to the swing arm (30) about a second pivot axis (A2) extending in parallel with said first pivot axis (A1), and
- an electric motor (33) for pivoting the swing arm (30) in relation to the first mounting bracket (10) about said first pivot axis (A1),

characterized in:

- **that** the swing arm unit (1) comprises a reduction gear system (40), which is configured to act between the motor (33) and the first joint (11) and through which the motor (33) is capable of pivoting the swing arm (30) in relation to the first mounting bracket (10) about said first pivot axis (A1); and
- **that** the motor (33) and the gear system (40) are mounted to the swing arm (30) so as to be carried by the swing arm and move together with the swing arm when the swing arm is pivoted in relation to the first mounting bracket (10) about said first pivot axis (A1).

2. A swing arm unit according to claim 1, **characterized in:**

- **that** the first joint (11) comprises a pivot pin (14) non-rotatably connected to the first mounting bracket (10);
- **that** the reduction gear system (40) comprises a gear member (41) non-rotatably connected to said pivot pin (14); and
- **that** the gear system (40) comprises a set of gear wheels acting between the motor (33) and said gear member (41).

3. A swing arm unit according to claim 1 or 2, **characterized in that** the gear system (40) is mounted in an internal space of the swing arm (30).

4. A swing arm unit according to any of claims 1-3, **characterized in:**

- **that** the first joint (11) comprises a first pivot pin (14) non-rotatably connected to the first mounting bracket (10);
- **that** the second joint (21) comprises a second pivot pin (24) non-rotatably connected to the second mounting bracket (20);
- **that** a first sprocket wheel (18) is non-rotatably connected to the first pivot pin (14);
- **that** a second sprocket wheel (28) is non-rotatably connected to the second pivot pin (24); and
- **that** a flexible transmission member (37) in the form of a sprocket chain or belt runs about said first and second sprocket wheels (18, 28) and is operably connected to them so as to make the second mounting bracket (20) pivot in relation to the swing arm (30) about said second pivot axis (A2) when the swing arm (30) is pivoted in relation to the first mounting bracket (10) about said first pivot axis (A1).

5. A swing arm unit according to claim 4, **characterized in that** the sprocket wheels (18, 28) and the flexible transmission member (37) are located in an internal space of the swing arm (30).

6. A swing arm unit according to claim 4 or 5, **characterized in that** the first sprocket wheel (18) has a larger diameter than the second sprocket wheel (28).

7. A swing arm unit according to claim 6, **characterized in:**

- **that** the swing arm (30) has a first side (31), which is intended to face away from the side door when the side door is in the closed position, and an opposite second side (32), which is intended to face the side door when the side door is in the closed position;
- **that** the transmission member (37) extends between the first and second sprocket wheels (18, 28) in a first path (P1) facing said first side (31) of the swing arm and in a second path (P2) facing said second side (32) of the swing arm; and
- **that** the part of the transmission member (37) extending along said first path (P1) is elastically extendable against the action of a spring force.

8. A swing arm unit according to claim 7, **characterized in that** a spring member (38) is provided on the part of the transmission member (37) extending along said first path (P1) so as to provide said spring force.

9. A swing arm unit according to claim 7 or 8, **characterized in that** the swing arm (30) has a curved shape as seen in a planar view, said first side (31) of the swing arm being essentially convex and said second side (32) of the swing arm being essentially concave.

10. A car, **characterized in that** the car comprises a rear side door (2) mounted to a C pillar (4) of the car body by means of a swing arm unit (1) according to any of claims 1-9.

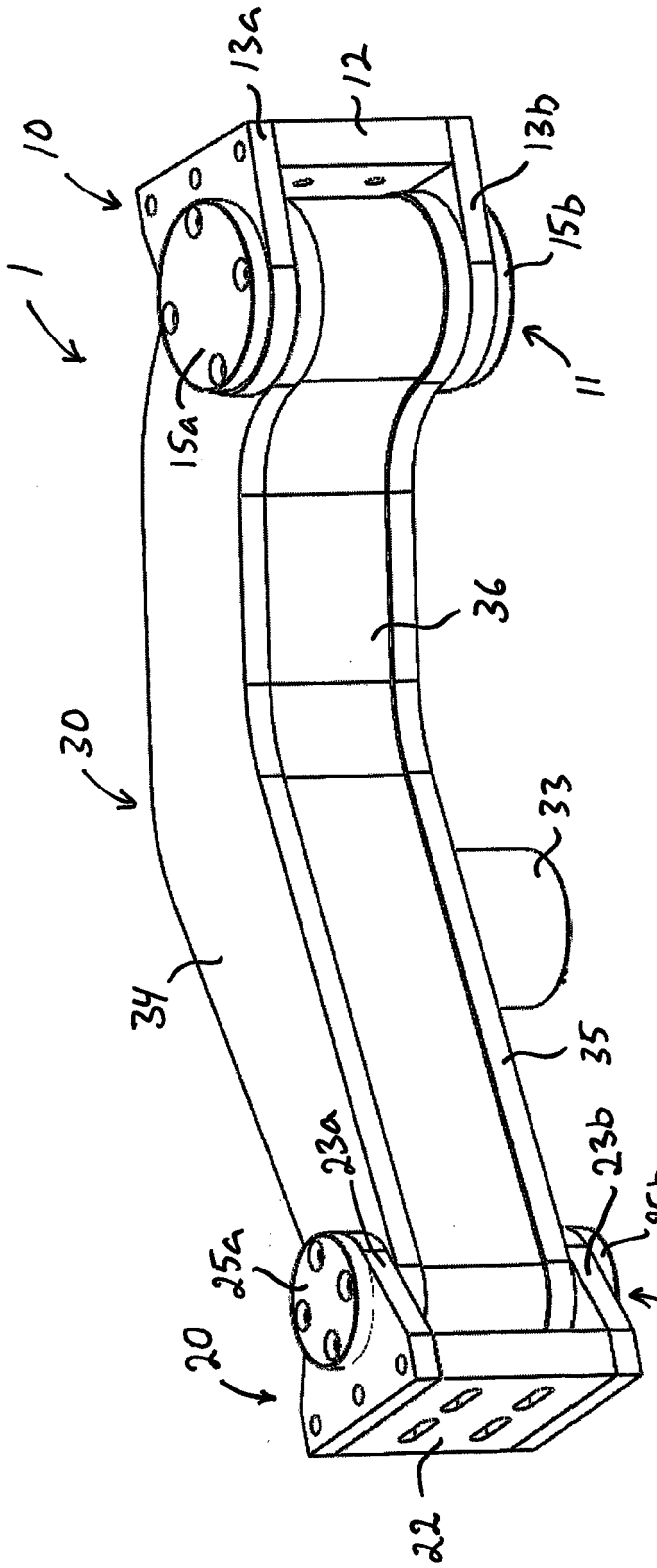

Fig 1

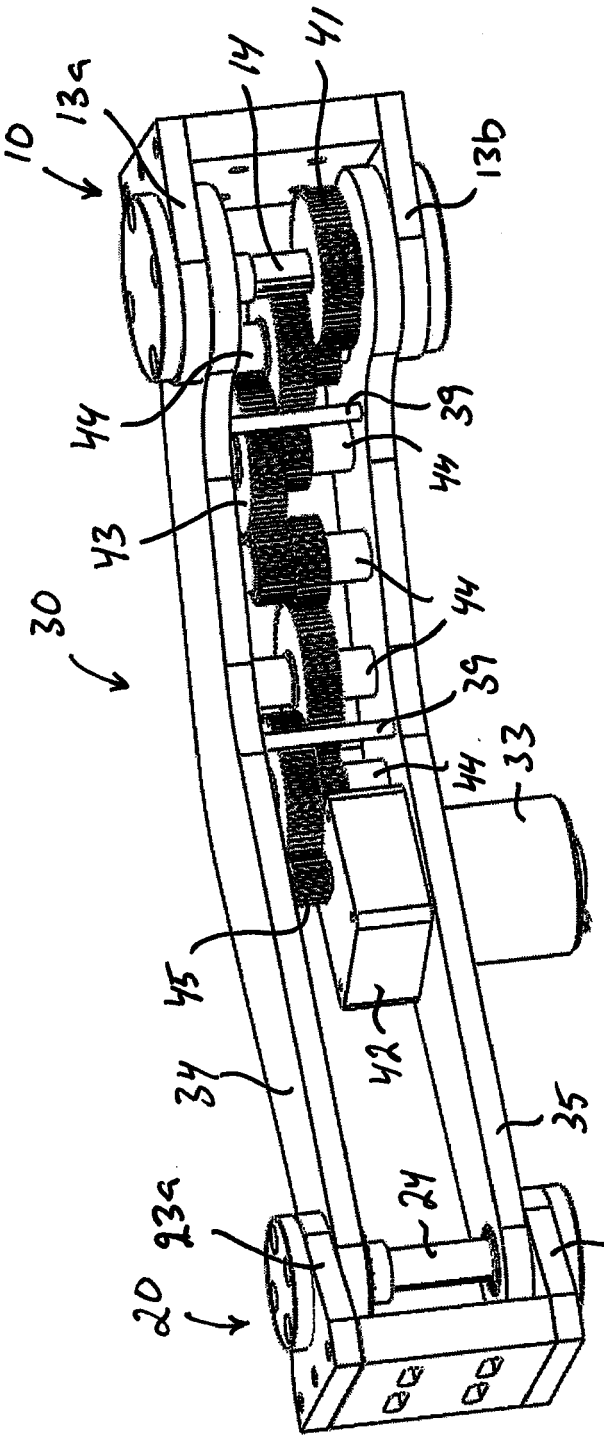

Fig 2

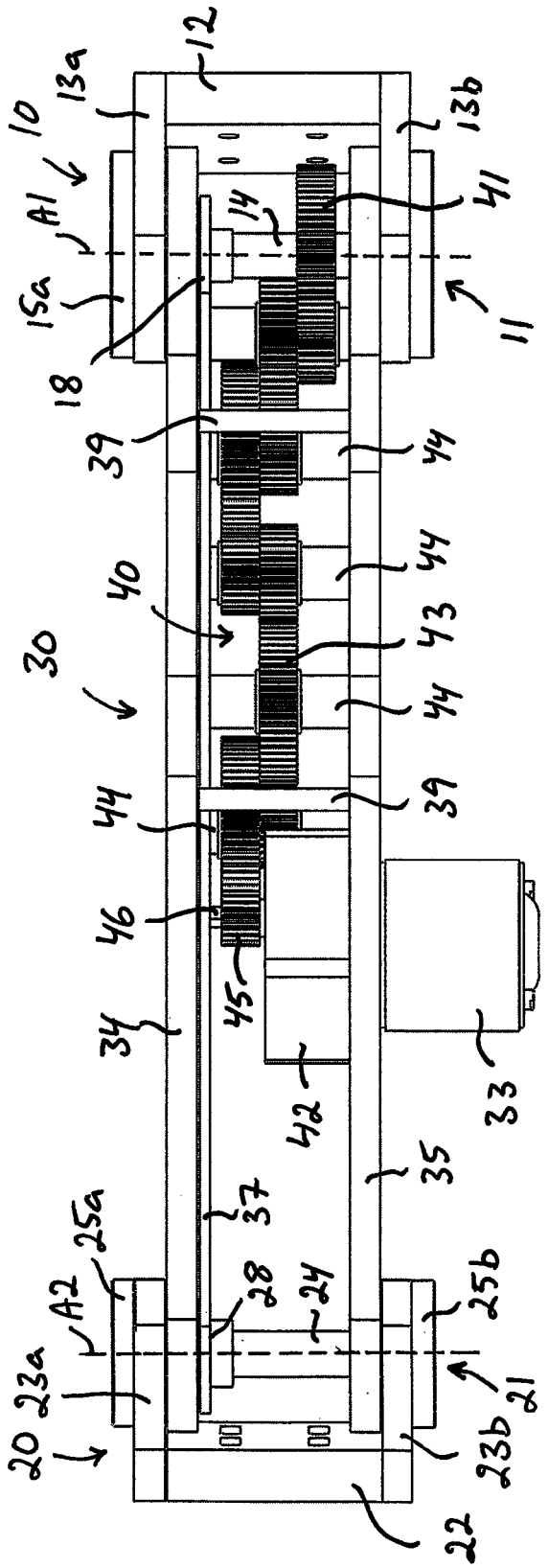
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Fig 3

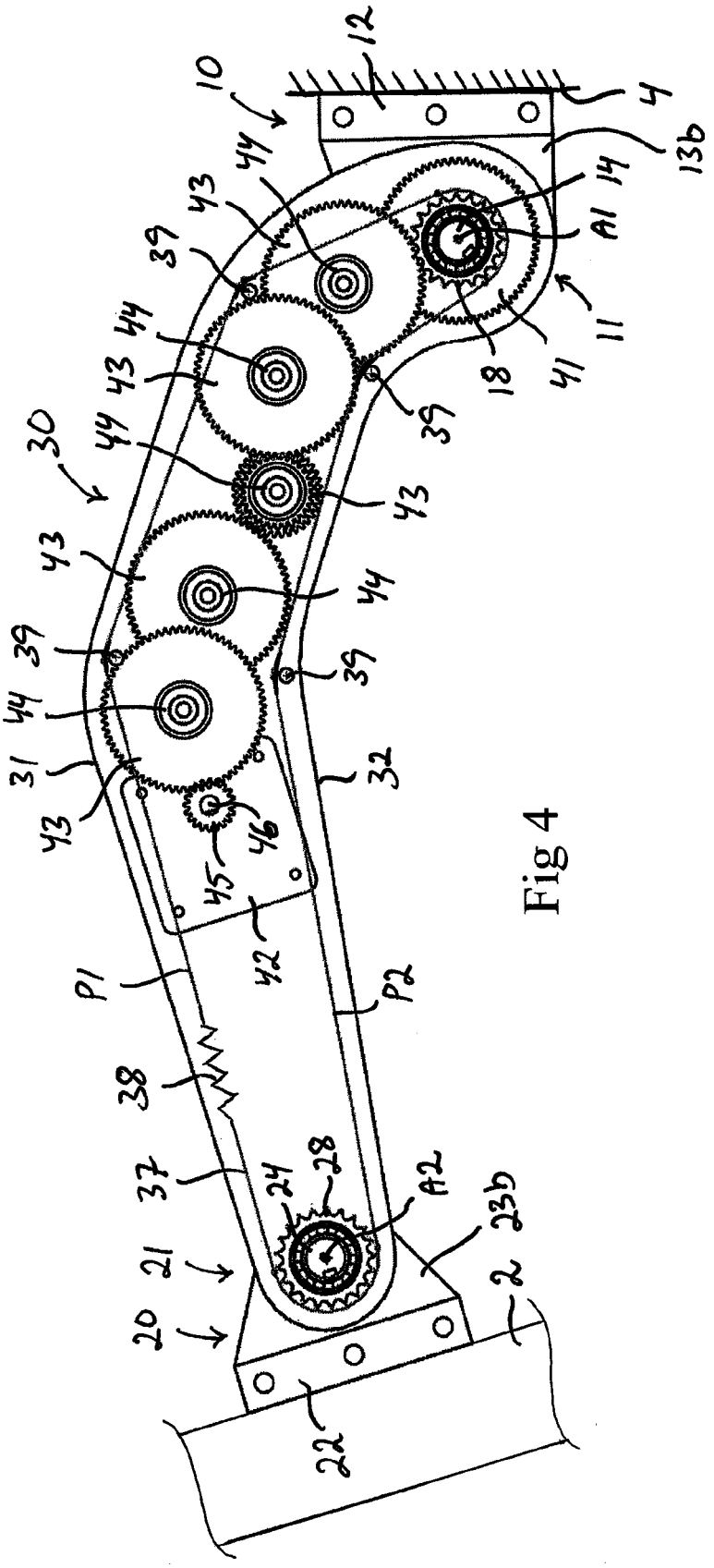
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Fig 4

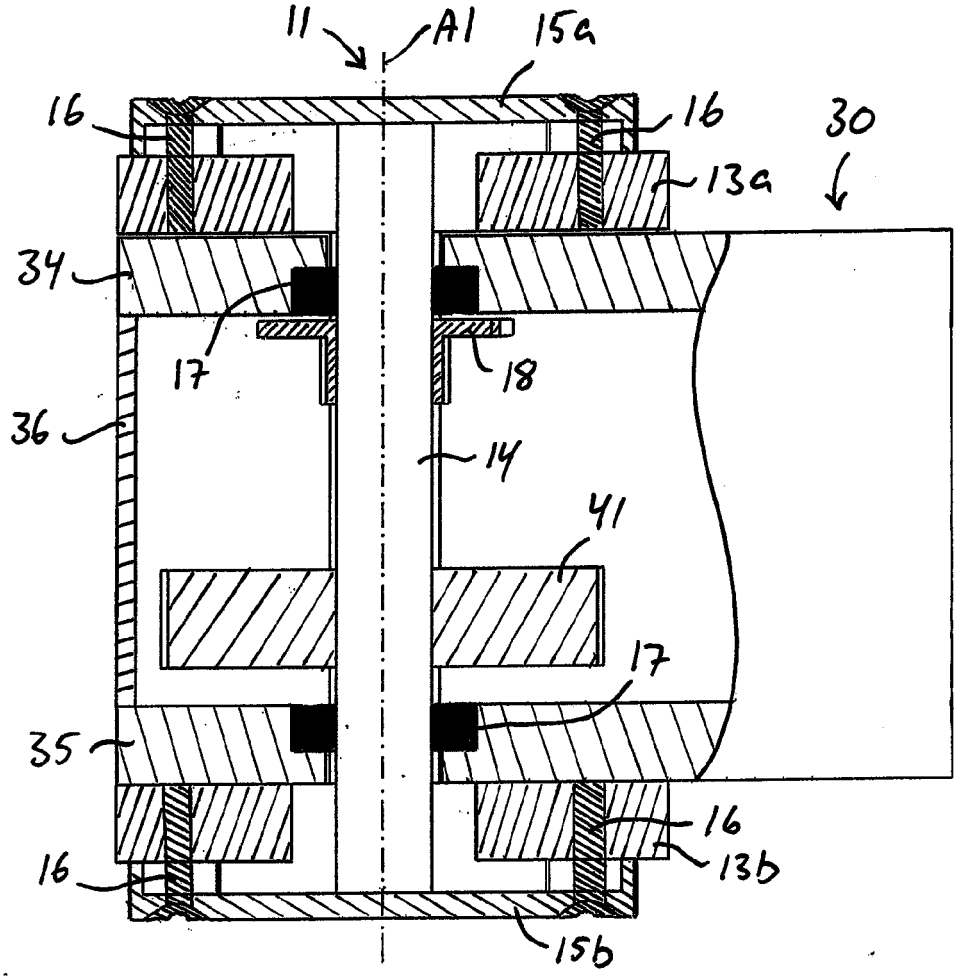

Fig 5

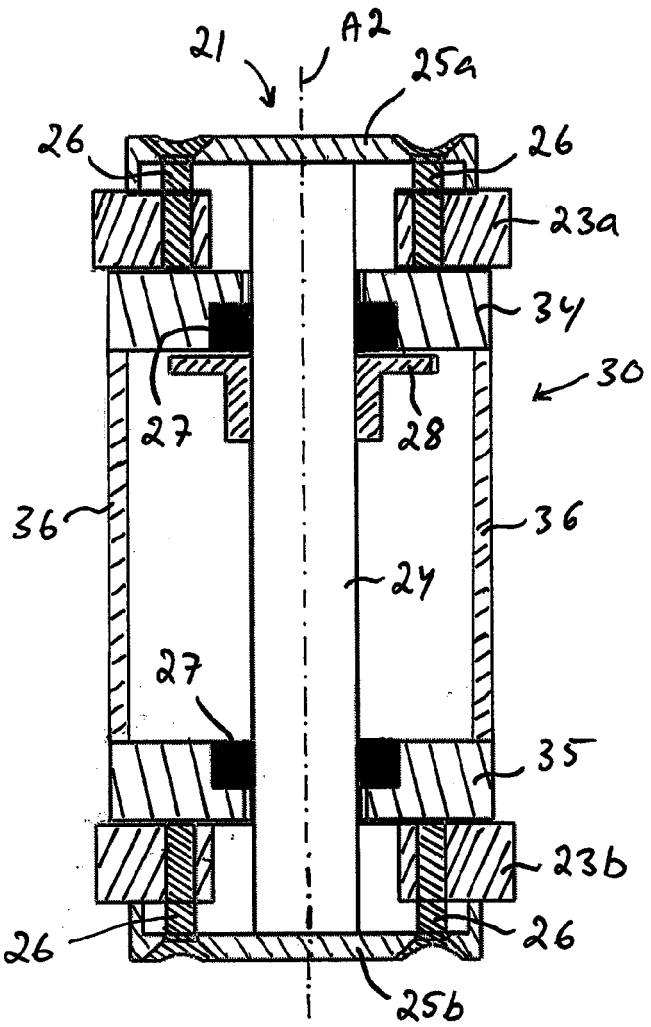

Fig 6

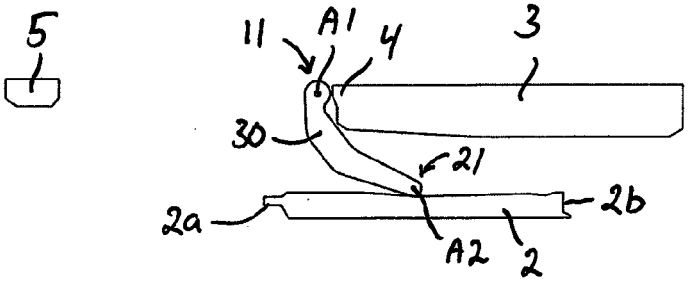

Fig 7a

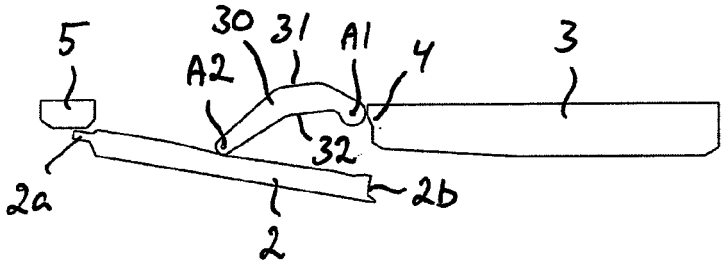

Fig 7b

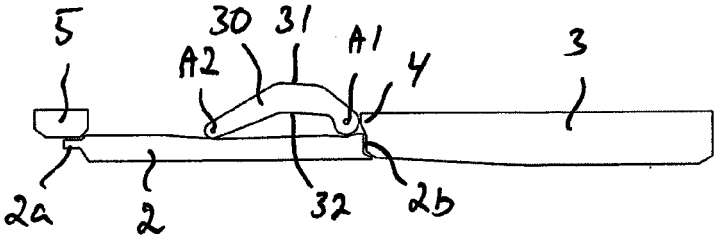

Fig 7c

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EUROPEAN SEARCH REPORT

Application Number
EP 09 16 2421

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Place of search	Date of completion of the search	Examiner
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