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STAIR-CLIMBING VEHICLE FOR WHEELCHAIR

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(56) Prior Art Documents
DE 3150193
EP 436103
US 4566707

(57) Claim

1 . A stair-climbing vehicle for transporting a wheelchair with a person sitting on, the stair-climbing vehicle comprising:

a crawler mechanism formed by a pair of endless belt crawlers disposed on opposite sides of the vehicle;

a vehicle body including a driving motor for driving the crawler device to enable the stair-climbing vehicle to climb up or down a stairway;

a load-carrying platform for mounting a wheelchair, said load-carrying platform being provided above the vehicle body and capable of pivoting in vertical direction about one end thereof;

wherein the vehicle body and the load-carrying platform are connected with each other through a first electrically driven cylinder, the load-carrying platform being provided with an inclination sensor;

wherein the inclination sensor includes a first inclination sensing element and a second inclination sensing element, each inclination sensing element is a tubular member containing a flowable electrically conductive material and a pair of electrically conductive terminals;

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wherein the first inclination sensing element is arranged to form an angle α with a horizontal plane, the second inclination sensing element is arranged to form an angle β with an extended line of the first inclination sensing element.

P/00/011
Regulation 3.2

AUSTRALIA

Patents Act 1990

ORIGINAL

COMPLETE SPECIFICATION

STANDARD PATENT

Invention Title: STAIR-CLIMBING VEHICLE FOR WHEELCHAIR

The following statement is a full description of this invention, including the best method of performing it known to us:

GH REF: P24283-C:JDF:RK

TITLE OF THE INVENTION

Stair-climbing Vehicle for Wheelchair

BACKGROUND OF THE INVENTION

The present invention relates to a stair-climbing vehicle, in particular to a stair-climbing vehicle for transporting a wheelchair with a person sitting on.

In fact, the applicant of this application has suggested a stair-climbing vehicle for wheelchair, which was disclosed in Japanese Patent Application Laid-open No. 4-154493, as illustrated in Fig. 7. Referring to Fig. 7, the conventional stair-climbing vehicle comprises a crawler device a which includes a pair of endless belt crawlers each extending in the longitudinal direction thereof over at least two steps of a stairway while climbing up or down the stairway, a load-carrying platform C for holding a wheelchair with a person sitting on, two pairs of travelling wheels C1 (with one pair provided under the front portion of the load-carrying platform C and another pair provided under the rear portion thereof), an electric cylinder b for pivotally raising the load-carrying platform C, an operation handle d for operating the stair-climbing vehicle.

When travelling on a horizontal ground surface, the electric cylinder b is caused to retract so that all the travelling wheels C1 will get in contact with ground surface. When climbing up or down a stairway, a change-over switch (not

shown) provided on the operation handle d is operated to cause the cylinder b to extend, so that the load-carrying platform C is pivotally raised up to form an angle of 40° with respect with the crawler device a.

In this way, as shown in Fig. 7, a person sitting on the wheelchair may be moved up or down a stairway with his wheelchair slightly inclined rearwardly. In practice, in order to eliminate an uncomfortable or even a terrible feeling, the load-carrying platform C is designed. to be able to incline rearwardly a little when travelling up or down a stairway, such that the load-carrying platform C forms an angle of 5°- 10° with a horizontal plane.

However, when the stair-climbing vehicle is climbing up or down a stairway which has only a small inclining angle with a horizontal plane, the loading stand C will be inclined rearwardly too much if load-carrying platform C remains an angle of 40° with respect with the crawler device a. As a result, because the load-carrying platform is rearwardly inclined too much. a person sitting on the wheelchair will have an uncomfortable or even a terrible feeling. It is therefore desirable to provide a stair-climbing vehicle which addresses such a problem.

SUMMARY OF THE INVENTION

The present invention provides a stair-climbing vehicle for transporting a wheelchair with a person sitting on. The vehicle comprises a crawler mechanism formed by a pair of endless belt crawlers disposed on opposite sides of the vehicle; a vehicle body including a driving motor for driving the crawler device to enable the stair-climbing vehicle to climb up or down a stairway; a load-carrying platform for mounting a wheelchair, said load-carrying platform being provided above the vehicle body and capable of pivoting in vertical direction about one end thereof; wherein the vehicle body and the load-carrying platform are

connected with each other through a first electrically driven cylinder. The load-carrying platform is provided with a inclination sensor. The inclination sensor includes a first inclination sensing element and a second inclination sensing element, each inclination sensing element is a tubular member containing a flowable electrically conductive material and a pair of electrically conductive terminals.

In one aspect of the present invention, the first inclination sensing element is inclined forming an angle α with a horizontal plane of the load-carrying platform, preferably the angle α is 13° - 18° . The second inclination sensing element is inclined forming an angle β with an extended line of the first inclination sensing member, preferably the angle β is 5°-10°.

The flowable electrically conductive material is preferably mercury.

The crawler device may include a front operating member and a rear operating member, which are connected with each other and are capable of cooperating into an inverted "V" through a mutually connected point. Further, a rod of an extending/retracting cylinder may be connected to the rear operating member near the mutually connected point, such that the front operating member and the rear operating member are normally kept straight, but will be formed into an inverted "V" by cylinder's retracting movement, so as to effect a smooth movement of the stairclimbing vehicle from a stairway to a horizontal ground surface, or vice versa.

In the claims which follow and the preceding summary of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprising" is used in the sense of "including"; that is, the features specified may be associated with further features in various embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a side elevation showing a stair-climbing vehicle for wheelchair, constructedinsert c according to the present invention.

Fig. 2 is a side elevation showing a stair-climbing vehicle of Fig. 1, which is in position immediately before climbing up a stairway.

Fig. 3 is a side elevation showing a stair-climbing vehicle of Fig. 1, which is beginning to climb a stairway.

Fig. 4 is a side elevation showing a stair-climbing vehicle of Fig. 1 which is in the halfway of climbing a stairway.

Fig. 5 is a side elevation showing a stair-climbing vehicle of Fig. 1, which is arriving at a horizontal floor from a stairway.

Figs. 6a - 6h indicate electric circuits for controlling the pivoting movement of the load-carrying platform of the stair-climbing vehicle of Fig. 1.

Fig. 7 is a side elevation showing a stair-climbing vehicle of a prior art.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to Fig. 1, a stair-climbing vehicle 1 of the present invention comprises a vehicle body 2, a crawler devices 3 including a pair of endless belt crawlers disposed on opposite sides of the vehicle body 2, a

load-carrying platform 4 provided on the vehicle body 2 so as to be

vertically pivotable about one end thereof. An upright stand 5 is provided on the rear end of the load-carrying platform 1, and an inclination sensor 6 is provided on the upright stand 5.

The crawler device 3 includes a pair of front driving wheels 31, 31 provided on the front side thereof, a pair of rear driven wheels 32, 32 provided on the rear side thereof, a pair of rotating wheels 33, 33 disposed closed to the rear driven wheels 32, 32. A pair of endless belt crawlers 34, 34 are arranged to pass around and engage with the driving wheels 31, 31, the driven wheels 32, 32 and the rotating wheels 32, 32. A driving motor 35 and a speed reducer 36 are mounted in the front portion of the vehicle body 2. An electric cylinder 7 and another electric cylinder 8 are provided in the vehicle body 2. Also provided in the vehicle body 2 are battery for supplying electricity power to the motor 35, the cylinder 7 and another electric cylinder 8. Further, some electric elements 37 is also mounted on the vehicle body 2.

Between the driving wheels 31, 31 and the rotating wheels 33, 33 are provided a pair front operating members 38, 38 and a pair of rear operating members 39, 39. The front operating members 38, 38 and the rear operating members 39, 39 are pivotally supported on the crawler device 3. Moreover, each front operating member 38 and each rear operating member 39 are connected with each other so that they may cooperate to

form an inverted "\" with a connection point f at a top.

The rod portion of the cylinder 7 is connected to the rear operating member 39 near the connection point f. The electric cylinder 7 may be operated to extend or retract effected by a signal from the inclination sensor 6. The sensor 6 is so provided that as soon as it detects that the stair-climbing vehicle 1 has climbed up to reach the upmost step of a stairway, the electric cylinder 7 will retract.

When the stair-climbing vehicle 1 is travelling on a horizontal ground surface or climbing up or down a stairway, the electric cylinder 7 is caused to extend, so that a front operating member 38 and a rear operating frame 39 are kept at a straight line, thereby enabling the stair-climbing vehicle 1 to move in a stabilized manner. Further, when the stair-climbing vehicle 1 reaches the upmost step of a stairway, the vehicle 1 will be changed from an inclined position into a horizontal position, or vice versa. Such kind of movement will be detected by the sensor 6 which will then cause the electric cylinder 7 to retract. As a result, the front operating member 38 and the rear operating member 39 will cooperate to form an inverted "V", as shown in Fig. 5. In this way, since the belt crawler 34 is caused to bend into an inverted "V", the stair-climbing vehicle 1 does not have to change a great deal in its travelling position so as to effect a smooth movement from stairway to horizontal ground surface or vice versa (see Fig. 5).

The load carrying platform 4 is provided on the vehicle body 2 and it is pivotable in vertical direction about the rear end thereof.

The load-carrying platform 1 has a pair of front casters 41, 41 and a pair of rear casters 42, 42. When travelling on horizontal ground surface, the electric cylinder 8 is retracted, so that the front casters 41, 41 and the rear casters 42, 42 will project beyond the ground contacting surface of the crawler device 3, upwardly separating the crawler device 3 from the ground surface, thereby enabling the vehicle 1 to run on the ground surface by means of the front caster 41, 41 and the rear caster 42, 42, as illustrated in Fig. 1.

As illustrated in Fig. 2, when the stair-climbing vehicle 1 is about to climb up a stairway, the electric cylinder 8 will extend so as to cause the load-carrying platform 4 to upwardly pivot about the rear end thereof, enabling the front casters 41, 41 and the rear casters 42, 42 to upwardly separate from the ground surface, making the crawler device 3 to get in contact with the ground. In this manner, the vehicle 1 is able to start its climbing up a stairway by driving the crawler device 3.

The load-carrying platform 4 is constructed to mount a wheelchair. In fact, a sliding plate (not shown) is received in the front portion of the load-carrying platform 4. When a wheelchair is about to be mounted on the load-carrying

platform 4, the sliding plate slides out to serve as a slope plate between the ground surface and the front portion of the load-carrying platform 4. Thus, a wheelchair may be moved from the ground surface through the slope plate onto the load-carrying platform 4. Further, in order to prevent the wheelchair from dropping off the load-carrying platform 4, a pair of safety bars 43, 43 are provided on both sides of the load-carrying platform 4.

The upright stand 5 is provided on the rear end of the load-carrying platform 4. A first retaining device 51 and a second retaining device 52 are provided on the upright stand 5 in order to firmly hold the wheelchair on the load-carrying platform 4. Further, an operating handle 53 and an operation panel 54 are provided on the upper portion of the upright stand 5, thus, when moving the vehicle 1, an operator (person) can grip the handle 53 while performing necessary operation on the operation panel 54, thereby enabling the vehicle 1 to move in a desired manner.

One of the most important features of the present invention is that an inclination sensor 6 which includes a first inclination sensing element 61 and a second inclination sensing element 62 is provided on the upright stand 5.

The first inclination sensing element 61 is a tubular member having at one end thereof a pair of electrically conductive terminals 61a, 61b. Similarly, the second inclination sensing element 62 is also a tubular member having at one end

thereof a pair of electrically conductive terminals 62a, 62b. Each of the tubular members contains a flowable mercury material 61c or 62c having a predetermined quantity enough to make conductive between the terminals 61a and 61b or between the terminals 62a and 62b. When the mercury material 61c or 62c gets in touch with the terminals 61a and 61b or the terminals 62a and 62b, the terminals 61a and 61b or the terminals 62a and 62b will become electrically conducting with each other. As a result, a motor 81 for driving the electric cylinder 8 will be energized, which will be described in more detail later.

As shown in an enlarged part of Fig. 1, the first inclination sensing element 61 is arranged to form an angle α with a horizontal plane. Preferably, the angle α is 15° with the right end of the element 61 being higher as indicated in the drawing. Further, the second inclination sensing element 62 is arranged to form an angle β with an extended line of the first inclination sensing element 61. Preferably, the angle β is 5° with the right end of the element 62 being higher as indicated in the drawing.

An electric circuit 9 in connection with the first and second inclination sensing elements 61 and 62 is indicated in detail in Fig. 6a. As illustrated in Fig. 6a, the electric circuit 9 includes the terminals 61a, 61b, 62a, 62b, a battery 37, a motor 81 which is used for driving the electric cylinder 8. The circuit 9 further includes a manual switch 91,

electro-magnetic coils 92, 93, change-over switches 94 and 95 operated by the electro-magnetic coils 92, 93. In practice, the change-over switches 94 and 95 are normally in contact with points B in the circuit.

The operation of the stair-climbing vehicle 1 will be described in detail below with reference to Figs. 1 - 5 and Figs. 6a - 6h.

Referring to Fig. 1, when the stair-climbing vehicle 1 is moving on a horizontal ground surface, the load-carrying platform 4 and the vehicle body 2 are in a horizontal and mutually parallel position, so that the pair of front casters 41, 41 and the pair of rear casters 42, 42 (all provided on the underside of the load-carrying platform 4) are in contact with the ground surface.

When the stair-climbing vehicle 1 is about to travel from the horizontal ground onto a stairway so as to climb up or down the stairway, the manual switch 91 (connected to and provided on the surface of the operation panel 54) is switched ON (Fig. 6b). At this moment, since the first inclination sensing element 61 is in a position having an angle α 15° with a horizontal plane, the mercury material 61c will move downwardly to touch with the terminals 61a and 61b located at lower end of the tubular member, therefore the terminals 61a and 61b become electrically conductive with each other. Thus, as shown in Fig. 6b, since the manual switch 91 is ON (in contact with side A), the electro-magnetic coil 92 will be

onergized to generate a magnetic attracting force, so as to cause the change-over switch 94 to get in contact with side A. Consequently, the motor 18 will begin to rotate in one predetermined direction so that the electric cylinder 8 will extend. Then, as fast as the load-carrying platform 4 is pivoted upwardly to form an angle of 15 ° with the vehicle body 2, the flowable mercury material 61c will move to the other end of the cylindrical member, so that the circuit 9 will be interrupted and the motor 81 will stop, as shown in Fig. 6c.

At this moment, the vehicle 1 will be in a position shown in Fig. 2. As shown in Fig. 2, since the load-carrying platform 4 is pivoted upwardly to form an angle with the vehicle body 2, the front casters 41, 41 and the rear casters 42, 42 will be raised so as to be separated from the ground surface, causing the crawler device 3 to contact with the ground surface. With the load-carrying platform 4 inclined rearwardly forming an angle of 15 ° with the vehicle body 2, a person sitting on a wheelchair will not have an uncomfortable or a terrible feeling while the vehicle 1 is climbing up or down a stairway.

Referring to Fig. 3, when the stair-climbing vehicle 1 has begun its climbing up or down a stairway by driving its crawler device 3, the load-carrying platform 4 is pivoted upwardly still further. During this process, as shown in Fig. 6d, the flowable mercury material 61c of the first

inclination sensing element 61 moves back to get in touch with the terminals 61a, 61b again, so that the circuit 9 is again energized and the motor 81 will begin to rotate again, thereby causing the electric cylinder 8 to extend still more, thus enabling the load-carrying platform 4 to pivot upwardly still further.

Thus, when the stair-climbing vehicle 1 begins to climb up or down a stairway, although there is a tendency for the load-carrying platform 4 to incline forwardly a little corresponding to a stairway inclination condition, but in fact this kind of forward inclination will be completely prevented since the load-carrying platform 4 has already inclined rearwardly forming an angle of 15° with the vehicle body 2.

As shown in Fig. 4, when the load-carrying platform 4 is disposed at least on a horizontal position, or slightly inclined rearwardly forming a small angle with the vehicle body 2, the flowable mercury material 61c will move to the other end of the cylindrical member 61, so that the circuit 9 will be interrupted again and the motor 81 will stop, as shown in Fig. 6e.

In this way, a person sitting on a wheelchair will not have an uncomfortable or a terrible feeling while the vehicle 1 is climbing up or down a stairway.

Referring to Fig. 5, when the stair-climbing vehicle 1 reaches the upmost step of a stairway, it is necessary for the

vehicle 1 to change from its inclined position into its horizontal position. At this time, another sensor (not shown) will detect the arrival of the vehicle 1 at the upmost step of the stairway, supplying an operation signal to the cylinder 7 so as to caused the cylinder 7 to retract, thereby enabling the front operating member 38 and the rear operating member 39 to cooperate in order to form an inverted "V". With the cooperation of the members 38, 39 to form the inverted "V", the belt crawler 34 is also caused to bend into an inverted "V" shape. As a result, the stair-climbing vehicle 1 does not have to change greatly in its travelling position so as to effect a smooth movement from stairway to horizontal ground surface, or vice versa.

When the stair-climbing vehicle 1 travels from a stairway to a horizontal ground surface, since the load-carrying platform 4 is inclined rearwardly, the flowable mercury material 62c will move to the other end of the cylindrical member 62 (Fig. 6f), permitting electric connection between terminals 62a and 62b. In this way, as shown in Fig. 6f, the circuit 9 is energized and the electro-megnetic coil 95 will generate magnetic force to attract the change-over switch 95 to the side A. Thus, the motor 81 will begin to rotate in an opposite direction to cause the electric cylinder 8 to retract.

Further, as fast as the load-carrying platform 4 is returned to its position as shown in Fig. 2 (an initially

inclined position), the flowable mercury material 62c will move back to its original position in the cylindrical member (Fig. 6g), thus the circuit 9 will be interrupted and the electric power supply will be shutoff.

Afterwards, as shown in Fig. 6h, by switching off the manual switch 91 (moving the switch 91 to contact side B), the motor 81 continues to rotate in the above opposite direction to cause the electric cylinder 8 to retract still further, thus causing the load-carrying platform 4 to change back to a complete horizontal position (as shown in Fig. 1).

As is understood from the above description, since the load-carrying platform 4 may be pivoted to form any desired angle with the vehicle body 2 in view of an actual inclining degree of a stairway, it has become surely possible to eliminate any uncomfortable or even terrible feelings a person might have when sitting on the wheelchair mounted on the stair-climbing vehicle climbing up or down a stairway.

Since the inclination sensing elements 61 and 62 employ a flowable mercury material 61c and 62c as an electrically conductive means, it is allowed not only to ensure a high reliability in use, but also to reduce the cost for the manufacture of a stair-climbing vehicle by dispensing with commercially available but quite expensive inclination sensors.

While the presently preferred embodiments of the this invention have been shown and described above, it is to be

understood that these disclosures are for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the invention as set forth in the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1 . A stair-climbing vehicle for transporting a wheelchair with a person sitting on, the stair-climbing vehicle comprising:

a crawler mechanism formed by a pair of endless belt crawlers disposed on opposite sides of the vehicle;

a vehicle body including a driving motor for driving the crawler device to enable the stair-climbing vehicle to climb up or down a stairway;

a load-carrying platform for mounting a wheelchair, said load-carrying platform being provided above the vehicle body and capable of pivoting in vertical direction about one end thereof;

wherein the vehicle body and the load-carrying platform are connected with each other through a first electrically driven cylinder, the load-carrying platform being provided with an inclination sensor;

wherein the inclination sensor includes a first inclination sensing element and a second inclination sensing element, each inclination sensing element is a tubular member containing a flowable electrically conductive material and a pair of electrically conductive terminals;

wherein the first inclination sensing element is arranged to form an angle α with a horizontal plane, the second inclination sensing element is arranged to form an angle β with an extended line of the first inclination sensing element.

2. A stair-climbing vehicle as claimed in claim 1, wherein the first inclination sensing element is inclined forming an angle α with a horizontal line of the load-carrying platform, preferably the angle α is 13°- 18°.

3. A stair-climbing vehicle as claimed in claim 1, wherein the second inclination sensing element is inclined forming an angle β with an extended line of the first inclination sensing element, preferably the angle β is 5°-10°.

4. A stair-climbing vehicle as claimed in claim, 1, wherein the flowable electrically conductive material is mercury.

5. A stair-climbing vehicle as claimed in claim 1, wherein the crawler device includes a front operating member and a rear operating member, which are connected with each other and are capable of cooperating into an inverted "V" through a mutually connected point.

6. A stair-climbing vehicle as claimed in claim 5, wherein a rod of a second electrically driven cylinder is connected to the rear operating member near the mutually connected point, such that the front operating member and the rear operating member are normally kept straight, but will be formed into an inverted "V" by cylinder's retracting movement, so as to effect a smooth movement of the stair-climbing vehicle from a stairway to a horizontal ground surface, or vice versa.

7. A stair-climbing vehicle substantially as herein described with reference to the accompanying drawings.

Dated this 28th day of October 1997

SUNWA LTD.
By their Patent Attorney
GRIFFITH HACK

Stair-climbing Vehicle for Wheelchair

Abstract of the Disclosure

There is provided a stair-climbing vehicle for transporting a wheelchair with a person sitting on. The vehicle comprise a crawler device including a pair of endless belt crawlers disposed on opposite sides of the vehicle; a vehicle body including a driving motor for driving the crawler device to enabling the stair-climbing vehicle to climb up or down a stairway; a load-carrying platform for mounting a wheelchair, said load-carrying platform being provided above the vehicle body capable of pivoting in vertical direction about one end thereof. The load-carrying platform is provided with a inclination sensor. The inclination sensor includes a first inclination sensing element and a second inclination sensing element, each inclination sensing element is a tubular member containing a flowable electrically conductive material and a pair of electrically conductive terminals.

FIG.1

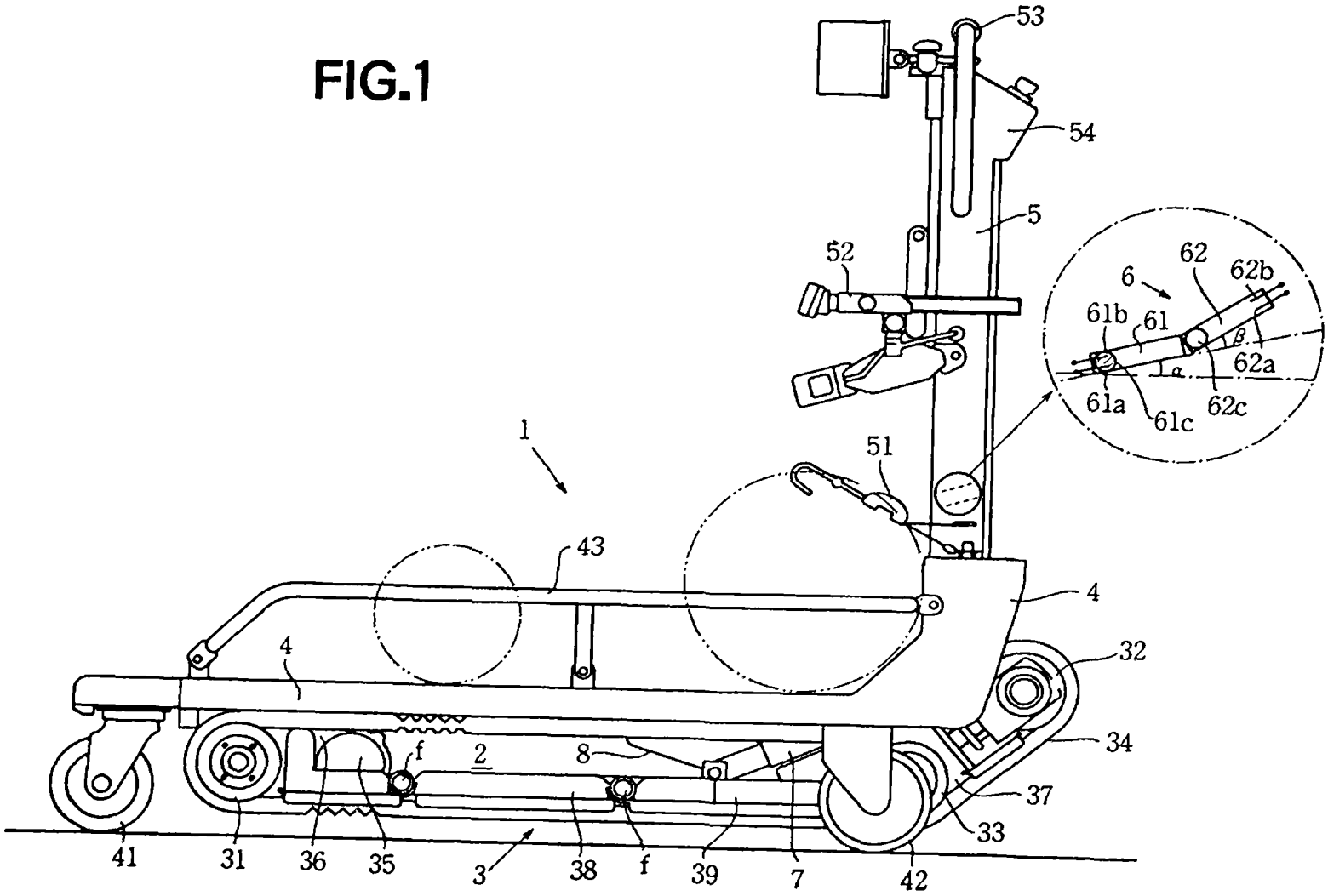

FIG.2

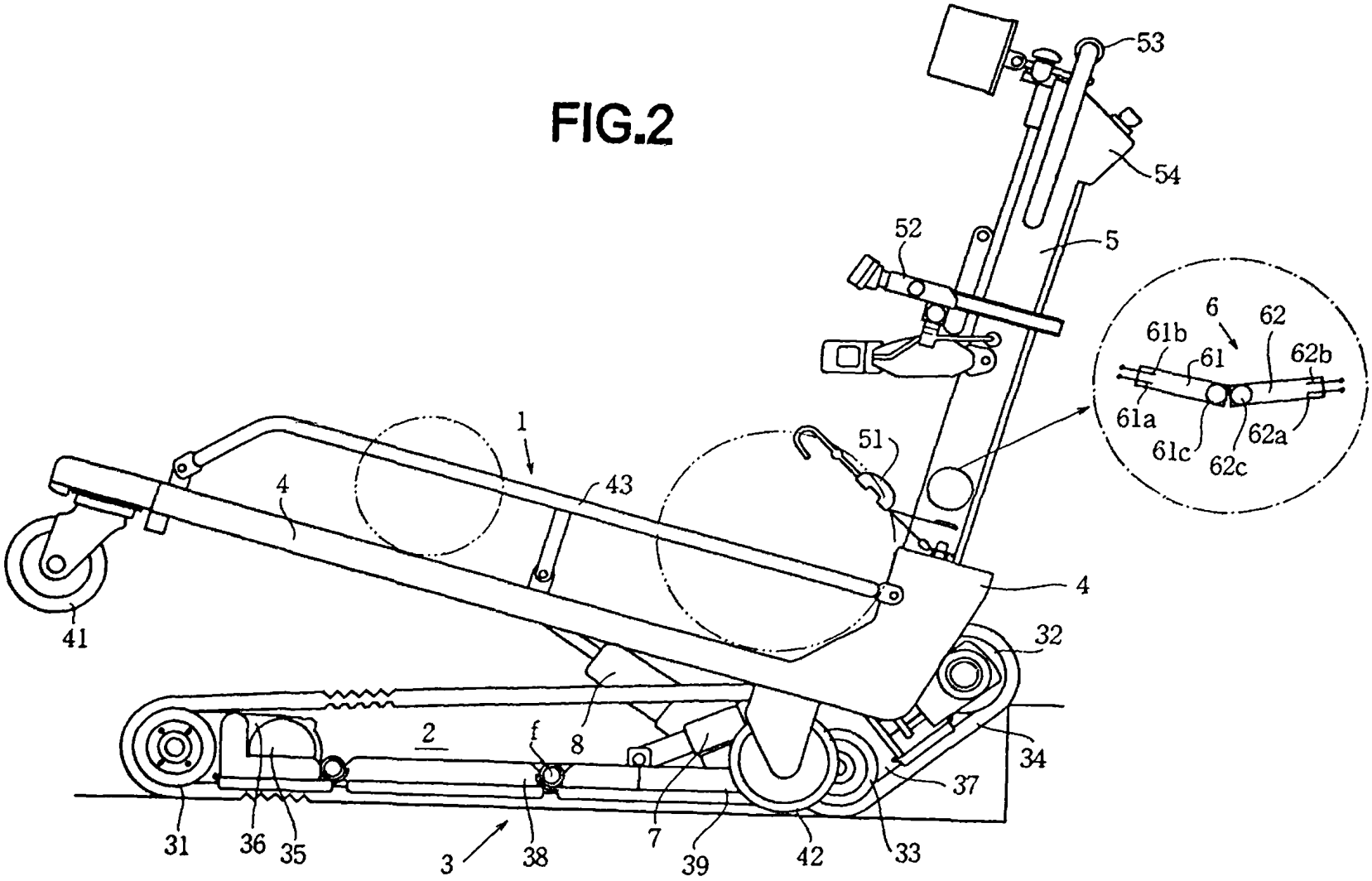
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FIG.3

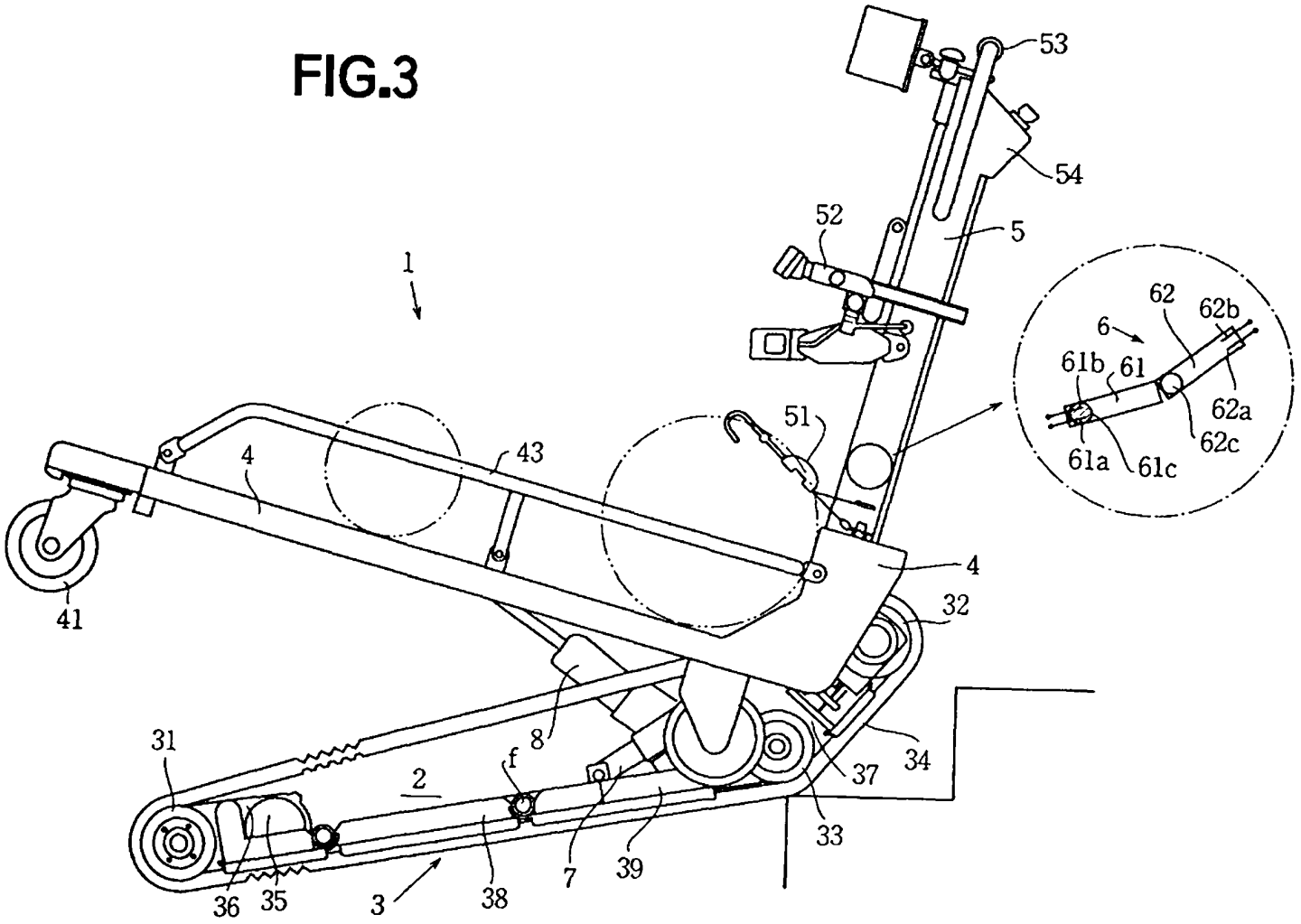
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FIG.4

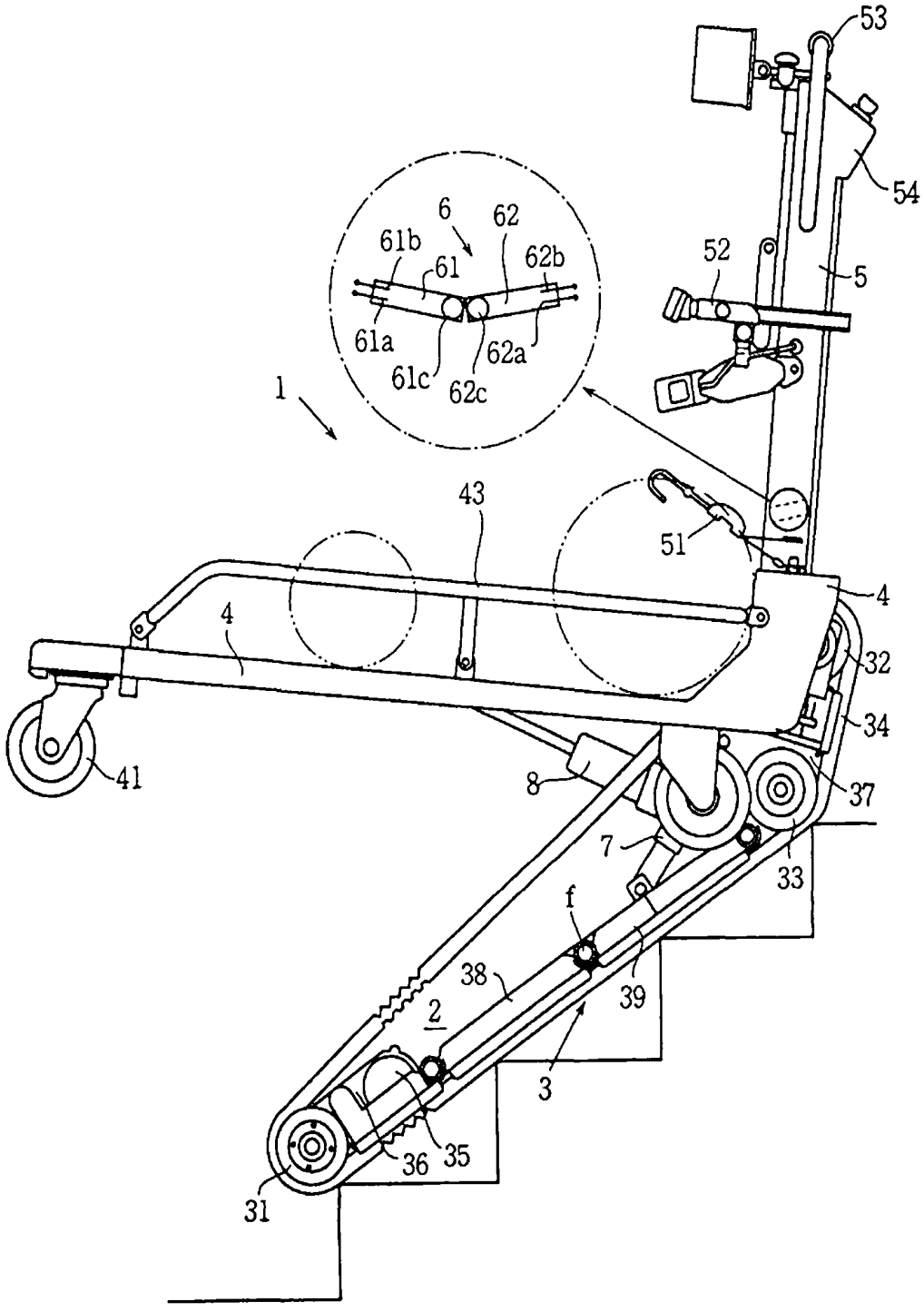


FIG.5

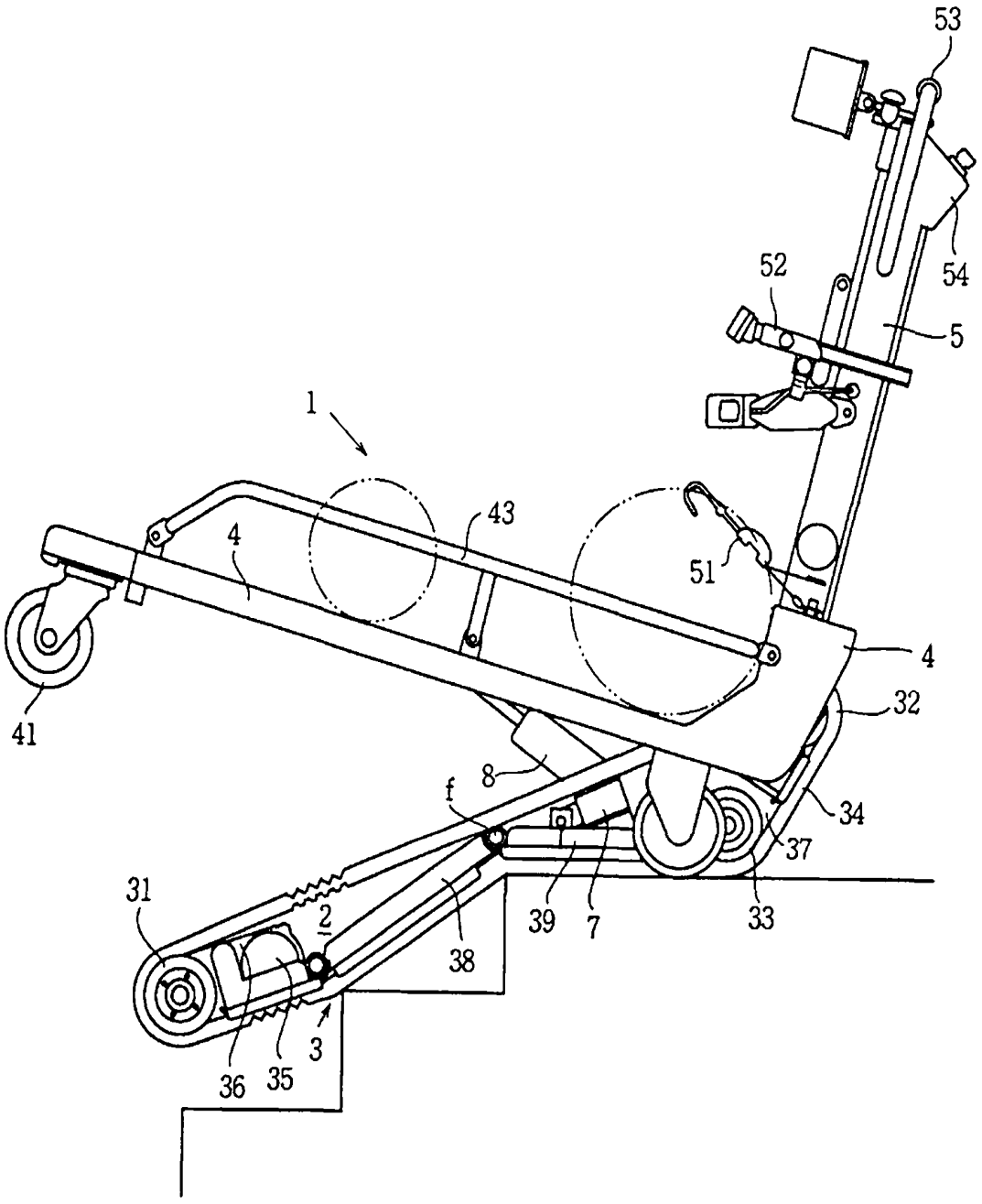


FIG.6 a

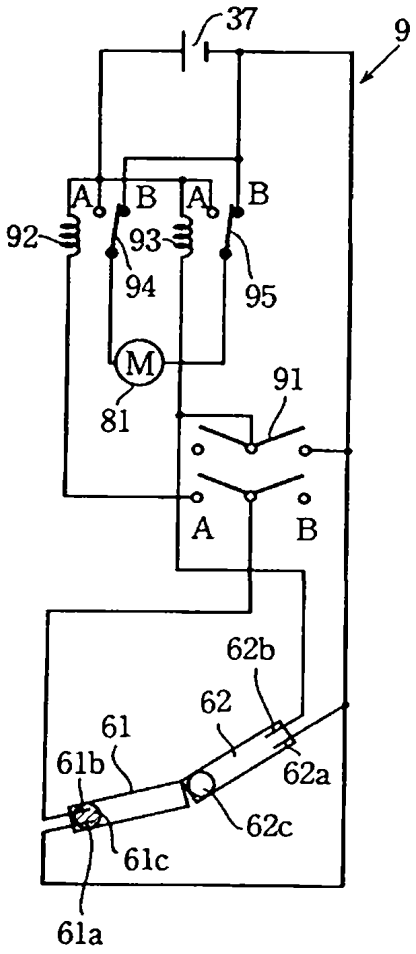


FIG.6 b

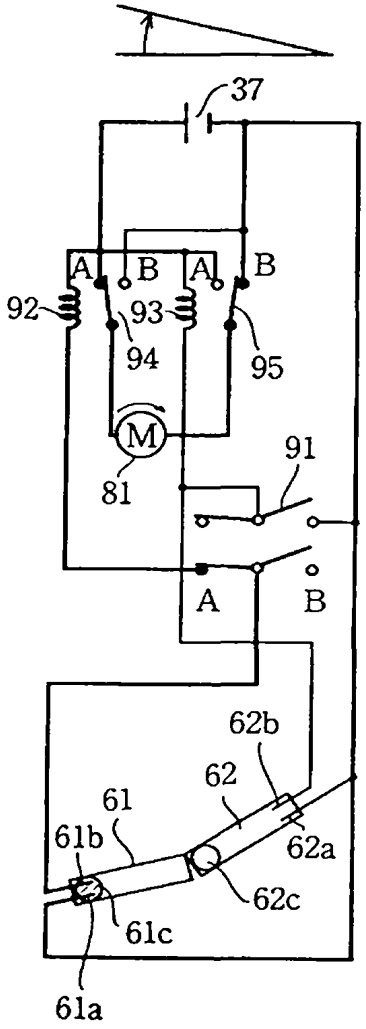


FIG.6 c

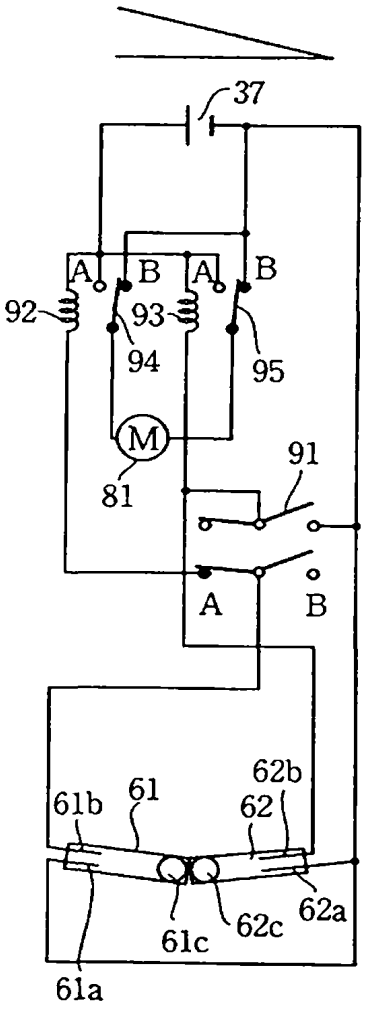


FIG.6 d

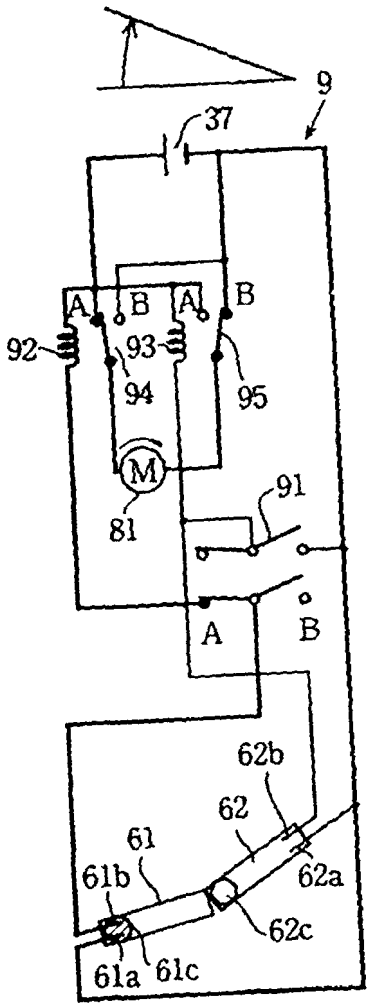


FIG.6 e

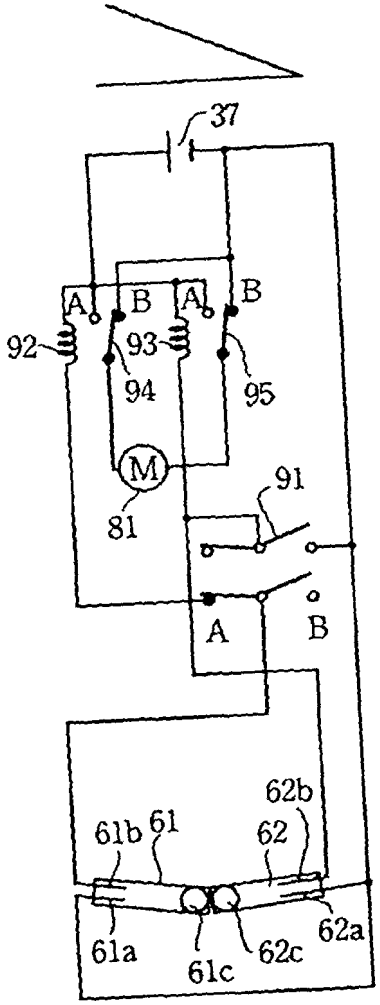


FIG.6 f

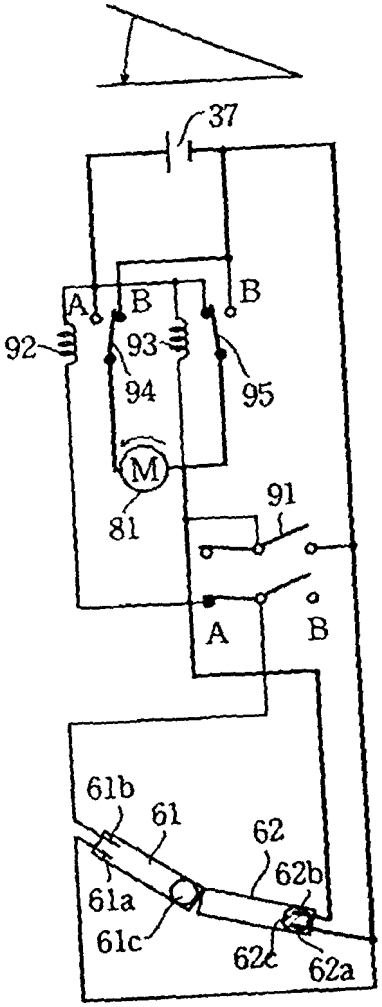
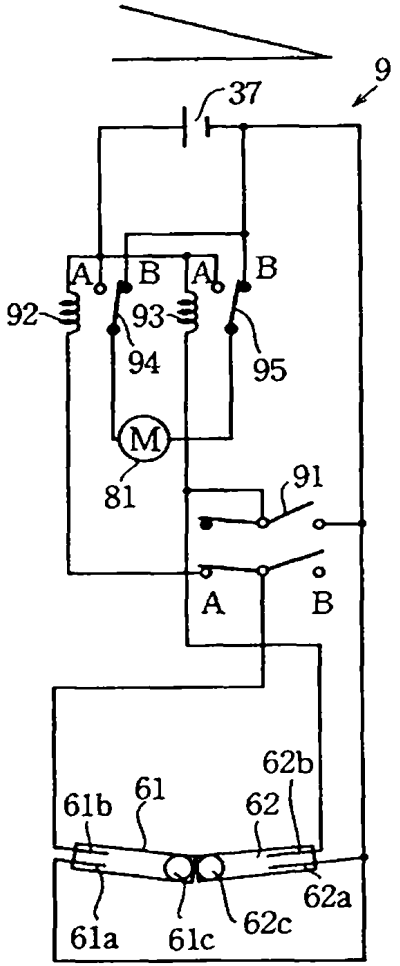


FIG.6 g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61
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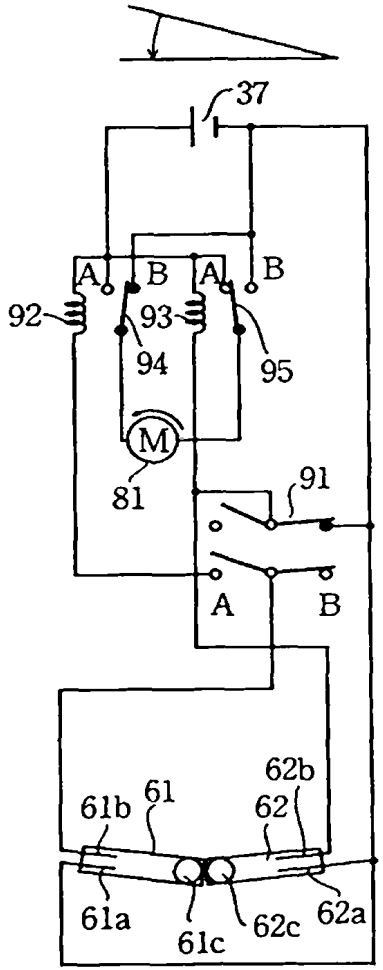
62a
61a
61c
62c

FIG.6 h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B
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93
94
95
M
81
91
A
B
62b
61b
61
62
62a
61a
61c
62c

FIG.7

PRIOR ART