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(54) **Door for vehicles, particularly railway and underground train carriages.**

(57) The door comprises two panels (2) slidable in a straight line towards and away from each other and mounted on a frame which, in turn,can move between a position of substantial alignment with the outer surface of the vehicle and a position outside this surface. The sliding of each panel (2) from the closed position towards the open position is thus effected by means of a translational movement of the frame (3,4) and a sliding movement of the actual panel (2) on the frame (3.4), performed in ordered sequence. Each panel is held (6) substantially barycentrically both in the closed position and in the open position. The translational movement of the frame (3.4) is controlled by a hydraulic jack actuating device, bearing in association with it a hook member which permits the movement of the frame towards the outer position only as a result of the operation of the actuating device.

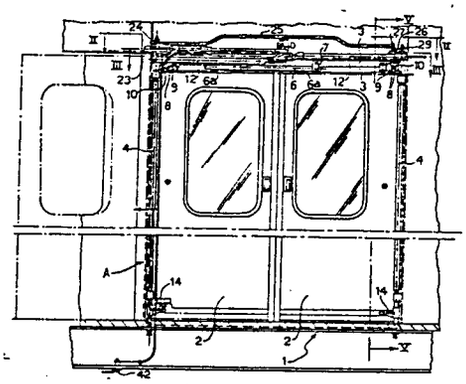

FIG. 1

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Description

Door for vehicles, particularly railway and underground train carriages.

The present invention relates to vehicle doors, and has been developed with particular reference to the problems associated with the construction of doors for railway and underground train carriages.

Doors for use on such vehicles these days comprise a generally plane frame defining the opening of the door and at least one panel mounted on said frame and movable between a closed position in which the panel extends in a first plane, in a position of alignment with a respective part of the door opening, and an open position in which the panel extends in a second plane parallel to and to one side of said first plane, substantially disengaged from the respective part of the door opening.

As a general rule, in doors of known type, the frame comprises horizontal guides constituted by two straight members connected by an intermediate S-shaped member which, when the panel moves in the longitudinal direction of the vehicle between the closed position and the open position, imparts to the panel itself an additional lateral movement towards the outside of the vehicle. In complementary manner, when the panel is returned towards the closed position, the said guides impart to the panel a return movement towards the inside of the vehicle.

This known solution has some fundamental drawbacks, substantially attributable to the fact that:-
- the design of the guides promotes the jamming of the panels during the sliding movement;
- in the body of the vehicle it is necessary to provide openings through which the S-shaped portion of the guides extend, and
- the actual design of the guides means that,in practice, the panels when in the open position must be supported in cantilever fashion, with considerable stress on their support members.

In principle, such drawbacks can be overcome by associating with the panels support devices of generally articulated-parallelogram type which make it possible to move each panel between the closed position and the open position by causing the actual panel, which is held substantially parallel to the plane of the door, to follow a semi-circular path. This solution, however, is not applicable to underground railway vehicles. The safety provisions which apply to such vehicles require that the amplitude of the outward movement of the panels be contained within certain limits (typically 50 mm).

The present invention sets itself the aim of providing a door for vehicles, as hereinbefore defined, which avoids the drawbacks specified above and which permits at the same time complete compatibility with the overall operational dimensions required by the regulations.

According to the present invention, this object is achieved by means of a door of the type specified hereinabove characterised in that, associated with said frame, there are movable support means, selectively actuable to impart to the actual frame a translational movement between said first and second planes, and in that said at least one panel is mounted on said frame with the ability to slide in a straight line in the direction of said first and second planes between said position of alignment and said position substantially disengaged from the respective part of the door opening, as a result of which the movement of said at least one panel between the closed position and the open position is performed by means of the translational movement of the frame and the straight line sliding movement of the actual panel on the frame, performed in ordered sequence.

Preferably, for each panel, said frame includes a straight guide member in which there is mounted, able to slide in a straight line, a support member for the panel which holds the actual panel in the substantially barycentric position.

The main advantages achieved with the invention are as follows:-
- the lateral movement of the panels is obtained by causing the frame which supports the panels to move towards the outside of the vehicle; the panels move on the frame with a sliding movement purely in a straight line whereby any risk of jamming is avoided;
- in the body of the vehicle it is sufficient to provide an opening able to receive the frame with the doors in the closed position; the sliding movement of the panels towards the open position is in fact effected after the frame has been expelled towards the outside of the vehicle as a result of which it is not necessary to provide openings for the guides in the side of the vehicle body;
- when, after the panels have been returned to a position of alignment with the door opening, the frame is returned inside the vehicle, the panels are securely prevented from opening by virtue of the fact that they beat against the vertical sides of the opening for receiving the frame, as a result of which any risk of accidental opening of the panels is avoided;
- the panels are supported in similar manner, that is to say, by means of a member which extends inside a respective straight guide, both in the closed position and in the open position, and approximately in the barycentric position in both cases, and
- the amplitude of the lateral movement of the panels corresponds in practice to the amplitude of the translational path of the frame, which is restricted to that strictly sufficient for taking the panels out of the position of interference with the vertical sides of the opening for the frame; this is a path of travel the amplitude of which can be contained within very narrow limits.

The invention will now be described, purely by way of non-limiting example, with reference to the appended drawings, in which:-

Figure I is a front elevation view, partly exploded, of a door for an underground railway carriage according to the invention, seen from inside the vehicle;

Figure 2 is a view along line II-II of Figure I;

Figure 3 is a view along line III-III of Figure I;

Figure 4 illustrates in greater detail the structure of the parts shown by arrow IV in Figure 2, and

Figure 5 is a section along line V-V of Figure I.

In the figures there is denoted overall by I a door for an underground railway carriage made according to the invention, mounted facing an opening A, of substantially rectangular shape, provided in one of the sides of the vehicle (not illustrated as a whole).

Door I essentially comprises a pair of panels 2 which are movable between a closed position, which is that shown in Figure I and as a continuous line in Figure 3, and an open position, shown by a dashed line only in Figure 3.

The panels 2 are mounted on a movable frame constituted substantially by a pair of channel-shaped guides 3 which extend through the dooor opening adjacent the upper ends of the panels 2, and by an assembly of supporting elements of which the essential members of which are two vertical rotary shafts 4 which, together with the horizontal guides 3, give the frame a generally portal-type configuration.

Thus, as will be more clearly seen in the sectional view of Figure 5, each panel 2 is provided at its upper end with a suspension member 6 slidable (for example with the interposition of ball bearings) inside the corresponding guide 3.

In Figure I there may be seen, in longitudinal view, the suspension member 6 associated with the panel 2 occupying the left-hand position in the figure.

As may be observed, the member 6 has a first portion 6a which extends above the respective panel 2, and a further portion 6b which extends towards the other panel 2 and overlies said other panel when the two panels 2 are in the closed position. In other words, the portion 6b protrudes into the respective panel 2 in a direction opposite that of sliding of the panel itself between the closed position and the open position.

This particular arrangement of the suspension member 6 is such that, when the respective panel 2 is brought (according to criteria which will be better explained hereinbelow) to the open position, the suspension member 6 itself continues to extend to a substantial degree inside the guide 3. In other words, the panel 2 is supported by the suspension member 6 under conditions which, from the point of view of the forces acting, are substantially identical in the closed position and in the open position. In particular, the connection arrangement of each panel 2 to the respective suspension member is chosen so that the panel 2 is held constantly in the substantially barycentric position. This prevents the suspension member 6 having to resist unbalancing moments tending to tilt the panel about the vertical.

The need to impart to the suspension member 6 a certain length leads to the use of two superimposed guides 3, each of which houses the suspension member of one of the panels.

In a position of alignment with the two guides 3 (which naturally are open towards the panels 2, i.e. towards the outside of the vehicle, and which are joined together by means of brackets 7 one of which is visible in Figure I), the shafts 4 are each provided with a pair of swing arms 8 which extend in a horizontal direction and support, by means of their facing free ends, a bushing 9 with a horizontal axis. The bushing 9 slides on a shaft which is also horizontal and is held at its ends by supports II fixed on the guides 3 on the side of the guides opposite the panels 2.

The arrangement is such that, as a result of a controlled rotation of the shafts 4, the arms 8 are able to swing in such a manner as to move the guides 3 between a first position - illustrated by a continuous line in Figure 3 - in which the two guides 3 extend in a first plane substantially aligned with the external surface of the body of the vehicle, and a second position - illustrated by a dashed line in Figure 3 - in which the guides 3 extend in a second plane, parallel to the first plane and shifted relative to the latter outwards from the carriage, by a distance of the order of 50 mm.

The guides 3 may be brought to the above-described first position of operation merely holding the panels 2 in the closed position, or in the position in which each panel is aligned with a respective portion of the door opening, occluding it. As will be seen more easily from Figure 3, under these conditions the panels 2 are in fact locked in a position of alignment with the door opening. The sliding of the actual panels on the guides 3 in the direction corresponding to the moving apart of the panels (opening of the doors) is in fact prevented by the bearing of the outer side of each panel against the vertical side of the opening A which directly faces it. Under such conditions, the door I is thus securely locked in the closed position.

In contrast, when the shafts 4 are made to rotate in such a manner as to move the guides into the second operating position or outer position, the panels 2 may be made to slide freely on the guides 3 under the action of respective pneumatic control jacks I2 disposed adjacent the upper ends of the panels 2, near the guides 3.

As will be more easily seen in the plan view of Figure 3, each jack I2 is connected at a first end I2a to one of the vertical sides of the opening A and acts at its opposite end I2b on a bracket I3 fixed to the respective panel 2.

The brackets I3 are mounted on the panels 2 adjacent the facing vertical edges of the panels themselves.

Overall sizing requirements dictate the employment of jacks I2 operating in a crossed or oppositely-placed fashion. According to this arrangement, each jack I2 is mounted adjacent one of the panels but in reality drives the movement of the other panel. With the panels in the closed position, the jacks I2, with the respective rods in their fully-retracted positions, lie in two superposed horizontal planes and are vertically aligned in a direction substantially parallel to the guides 3.

When the guides 3 are brought into the outer position, the free ends I2b of the jacks I2 are also slightly expelled towards the outside of the vehicle. Subsequent operation of the jacks causes the rods to extend from the cylinders and causes each jack I2 to exert a pushing force on the respective panel

(which, as has been seen, is the opposite one from that against which the jack 12 is placed) with, as a consequence, the moving apart of the panels 2 and the opening of the door.

It may therefore be understood that, in the door according to the invention, the moving of each panel from the closed position (Figure 1 and continuous line of Figure 3) the open position (dashed line in Figure 3) is effected as a result of two successive movements, driven sequentially.

The first movement, effected by the rotation of the shafts 4, is that which produces the translation of the guides 3, that is of the doorframe, towards the outside of the vehicle. The second movement, on the other hand, is the sliding movement in a straight line of the panels 2 on the guides 3 driven by the jacks 12.

In fully complementary manner, the movement of the panels 2 from the open position towards the closed position is also the outcome of the sequential actuation of two movements.

The first of these is the sliding movement in a straight line of the panels 2 on the guides 3 controlled by the jacks 12, while the second is the return movement of the guides 3 into the carriage, effected by the rotation of the shafts 4 in the opposite sense from that used during the opening operation.

Adjacent its lower end, each shaft 4 is in addition provided with a further arm 14 which carries at its free end a wheel or roller 15 able to run inside a horizontally-extending channel-shaped guide 16 mounted on the inside face of the respective panel 2.

The unit formed by the arm 14, the wheel or roller 15, and the channel-shaped guide 16, is intended to hold the respective panel 2, preventing its lower end from rocking relative to the vehicle. The panel 2 is in fact, so as to speak, suspended from the member 6 slidably mounted inside the guide 3 situated adjacent the upper end of the panel 2.

The arm 4 follows the swivelling movements of the arms 8 induced by the rotation of the shaft 4, allowing the panel 2 to be held in a vertical position when the guides 3 project outside the vehicle.

At the same time, the presence of the wheel or roller 15 means that, when the guides 3 project outside the vehicle, the panel 2 can slide freely relative to the arm 14, without the latter preventing the movement of panel 2 itself.

In order to retain the panels more securely in the closed position, a bracket member 17 may be provided in correspondence with the lower edge of each panel 2, the bracket member being provided with an opening 18 having a vertical axis, able to act as a catch for a bolt 19. The bolt 19 is movable in a vertical direction under the action of a pushing member 20, itself moved by an eccentric keyed on the shaft 4 below the floor P of the carriage.

In particular, when the shafts 4 are rotated into the position which causes the guides 3 to be withdrawn inside the vehicle, the eccentric 21 mounted on each shaft 4 pushes the member 20 in such a manner as to bring about the lifting of each bolt 19. These latter emerge from the floor P entering the openings 18. In this way, both panels are firmly held in the closed position, both at their upper ends and at their bottom ends, and are thus prevented from "flapping" as a result of transverse rocking of the carriage and/or violent ambient-pressure fluctuations.

In the construction of the devices which control the swinging movements of the two shafts 4, it is necessary to take two basic requirements into account.

The first requirement is to ensure that the rotational or swinging movements of the shafts 4 - and, consequently, the sliding movements of the two panels 2 - are synchronised.

The second requirement is to ensure that the guides 3 are held securely in their positions inside the carriage when the door is in the closed position and are expelled towards the outside of the vehicle only as a result of a positive control action. In other words, it is imperative to prevent the guides 3 from being expelled outside the vehicle, which would allow the eventual sliding and opening of the panels 2, as a consequence of a breakdown leading to a drop in the supply (hydraulic and/or electric) to the actuating members.

To meet the first requirement, the solution adopted is to combine an actuating device with only one of the shafts 4, utilising a transmission member for the transmission of the movement to the other shaft 4.

In the embodiment illustrated, the actuating device, represented overall by 22, is associated with the shaft 4 which is on the left-hand side of Figures 1 to 3.

The device 22, the structure of which will be made clearer with reference to Figure 4, acts on the free end of a crank 23 keyed the upper end of said left-hand shaft 4. The crank 23 is able to swing between a first operating position X', illustrated by means of a continuous line, and a second operating position X", shown by a dashed line.

On the same free end of the crank 23, or on the free end of another crank 24 situated above crank 23 (Figure 1) there is fixed one of the ends of a transmission rod 25 which extends above the guides 3 in a position substantially aligned with the actual guides 3.

The other end of the transmission rod 25 acts on reversing transmission gearing 26 comprising a first toothed wheel or segment 27 whose rotation is governed by a crank 28 the free end of which is connected to the transmission rod 25, and by a driven toothed wheel or segment 29 keyed on the upper end of the other shaft 4.

On rotation of the shaft 4 on which the actuating device 22 acts, the transmission rod 25 causes a corresponding synchronised rotary movement of the other shaft 4, in the opposite sense, however.

Such a manner of assembly ensures that, during the translational movement between the position of return inside the carriage and the outer position, the guides 3 (and consequently the panels 2 hanging on them) will remain parallel to the general plane of the opening A.

Figure 4 illustrates on a greater scale the structure of the actuating device 22, the purpose of which, as has been seen, is to drive the rotational movement of the shaft 4 by means of the crank 23 keyed to the

upper end of actual shaft 4.

The device 22 includes a support plate 30 fixed on the structure of the carriage.

An arm 3l, which can swivel about a generally vertical axis, is mounted on the plate 30. More precisely, the arm 3l has a first end 32 hinged in a fixed position relative to the plate 30, a free end 33 and an intermediate region 34 to which there is fixed one of the ends of a drive arm 35 consisting substantially of a pneumatic jack able to contract and expand selectively depending on commands given to it by an electropneumatic control unit (not shown).

The jack 35 has two ends. The first is denoted by 35a and is joined to the free end of the crank 23 which controls the swinging of arm 4. The second, denoted by 35b, is joined to the swinging arm 3l.

37 denotes overall a transmission arm having a first end 37a connected to the free end 33 of the pivoting arm 3l, and a second end 37b having generally a ramp configuration and cooperating with a tooth or latch 38.

Latch 38 is movable in a substantially radial direction relative to the shaft 4 and to the crank 23 in an arrangement such that:-

- in a first operating position, as illustrated with a continuous line in Figure 4, the latch 4 extends towards the shaft 4 and is therefore able to engage the crank 23, preventing its rotation from the first angular position X′ towards the second angular position X″;
- in a second operating position, as illustrated with a dashed line, the latch 38 moves away from the shaft 4 and from the free end of the crank 23, allowing the free swinging of crank 23 itself.

The latch 38 is biassed towards its first operating position, that is to say towards the position which effects the locking of the movement of the crank 23, by a flat spring 39.

The angular position X′ is that which the crank 23 adopts when the shaft 4 controlled by it is situated in the position in which the guides 3 which support the panels 2 are returned inside the carriage. The angular position X″ on the other hand, is the position to which the crank 23 must be recalled to induce in the shaft 4 the movement which causes the expulsion of the guides 3 towards the outside of the carriage.

The swinging movement of the crank 23 between the angular positions X′ and X″ is driven by the jack 35. In particular, when the jack 35 retracts, it pulls the crank 23 back towards the angular position X″. When the jack 35 expands, on the other hand, it pushes the crank 23 towards the first angular position X′.

The expansion of the jack 35 has, in addition, the effect of swinging the arm 3l in the direction corresponding to the moving of the arm itself away from crank 23.

As a result of this movement, the swinging arm 3l also moves the transmission arm 37 (which is connected at its end 37a to the free end 33 of the swinging arm 3l), leaving the latch 38 free to move into a position of engagement with the crank 23 under the action of the return spring 39.

In other words, when the jack 35 is given an expansion command to bring about the return of the guides 3 towards the inside of the carriage, it not only effects the necessary rotation of the shaft 4 controlled by it (and also of the other shaft 4 through the transmission rod 25) but also sets the latch 38 which locks the crank 23 securely in the first angular position X′.

Under such conditions, and also in the event of failure of the supply to the jack 35, the crank 23 is held securely in the angular position X′, with the result that the guides 3 cannot be expelled towards the outside of the carriage. In other words, with the crank 23 held in the angular position X′ by the latch 38, the door l is securely closed, even when there is a failure in the power supply to the jacks 35.

In order effect the opening of the door l, it is therefore necessary to disengage the latch 38 from the crank 23.

This result is obtained by retraction of the jack 35.

As a result of the axial contraction of the jack 35, the intermediate part 34 of the swinging arm 3l is made to come nearer the crank 23. The transmission arm 37 is thus pushed from by free end 33 of the actual swinging arm 3l causing the penetration of the end 37b into the seat of the latch 38. The latch 38 is thus moved away from the crank 23 and said crank may subsequently be shifted towards the angular position X″ as a result of the full retraction of the jack 35.

So that the door l may be opened in an emergency, an auxiliary arm 40 is mounted on the transmission arm 37 which controls the operation of the latch 38, the arm 40 being connected to two flexible control cables provided with operating levers 4l and 42 disposed respectively inside (lever 4l in Figure 2) and outside (lever 42 in Figure l) the door l.

The effect of the operation of one of the controls 4l or 42 is to cause the penetration of the end 37b of the arm 37 to penetrate the housing of the latch 38, according to criteria similar to those governing the release of the engagement device of the crank 23 when the jack 35 is retracted.

Claims

l. A door for vehicles, comprising a substantially flat frame (3,4) defining the opening of the door (l) and at least one panel (2) mounted on said frame (3,4) and movable between a closed position, in which said panel extends in a first plane, in a position of alignment with a respective part of the door (l) opening, and an open position in which said at least one panel (2) extends in a second plane, parallel to, and adjacent said first plane, and in a position of substantial disengagement from the respective part of the door (l) opening, characterised in that, associated with said frame (3,4) there are movable support means (4) selectively actuable (22) to impart to the actual frame (3,4) a translational movement between said first and said second planes, and in that said at least one

panel (2) is mounted on said frame (3,4) with the ability to slide in a straight line in the first and second planes between said alignment position and said position of substantial disengagement from the respective part of the door opening (I), whereby the movement of said at least one panel (2) between the closed position and the open position is effected by means of the translational movement of the frame (3,4) and the sliding movement in a straight line of the panel (2) itself in the frame (3.4) carried out in ordered sequence.

2. A door according to Claim I, characterised in that for each panel (2) said frame includes a straight guide member (3) in which, slidably mounted for movement in a straight line, there is a suspension member (6) for the panel (2) which supports the panel (2) in the substantially barycentric position.

3. A door according to Claim 2, characterised in that said suspension member (6) is substantially constituted by an elongate straight member having a first portion (6a) co-extensive with the respective panel (2) and a second portion (6b) protruding from the panel (2) in a direction opposite the direction of sliding of the actual panel (2) between said alignment position and said position of substantial disengagement from the respective part of the opening of the door (I).

4. A door according to any one of Claims 2 and 3, characterised in that said guide member (3) is situated adjacent the upper end of the respective panel (2) and in that a catch device (I4 to 2I) is associated with the bottom end of the panel (2) for locking the panel in the closed position, the catch device being activated by said movable support means (4) when the frame (3,4) is situated in said first plane.

5. A door according to any one of the preceding claims, characterised in that said movable support means comprise at least one shaft (4) rotatable about a vertical axis between first and second angular positions, in which the frame (3,4) is respectively situated in said first and second planes, and in that, associated with said rotary shaft (4), there is an actuation device comprising:-

- selectively retractable and extensible operating arm (35) having two ends (35a,35b), the first of which (35a) acts upon said rotary shaft (4,23);
- a swinging arm (3I) having an end (32) hinged in a fixed position relative to the vehicle, a free end (33) and an intermediate region (34) connected in drive-transmission relationship to the second end (35b) of the operating arm (35);

an engagement member (38) able to hold said rotary shaft (4,23) in said first angular position (X′), preventing the rotation thereof towards said second angular position (X″), and

- a transmission arm (37), substantially parallel to said operating arm (35), having a first end (37a) connected to the free end (33) of said swinging arm (3I) and a second end (37b) which acts upon said engagement member (38) in an arrangement whereby the retraction of the control arm (35) determines the release of the engagement member (38) and the subsequent rotation of the shaft (4,23) towards its second angular position (X″), and the extension of the control arm (35) brings about the rotation of the shaft (4,23) towards its first angular position (X′) and the subsequent activation of the engagement member (38), as a result of which the shaft (4) is prevented from rotating from its first angular position (X′) to its second angular position (X″) in the absence of a retraction of the operating arm (35).

6. A door according to Claim 5, characterised in that between said rotary shaft (4) and the first end (35a) of the operating arm (35), a crank (23) is interposed which swings about the axis of the shaft, and in that said engagement member is substantially constituted by a latch (38) movable in radial direction relative to the shaft (4) and to the crank (23) provided with ramp portions cooperating with the second end (37b) of said transmission arm (37).

7. A door according to Claim 5 or Claim 6, characterised in that an emergency opening mechanism (40,4I,42) is provided, able to act upon said transmission arm (7) with a view to producing the release of said engagement member (38).

8. A door according to any one of Claims 5 to 7, characterised in that:-

- two panels (2) are mounted on said frame (3,4)for sliding movement in opposite directions between said alignment position and said position of substantial disengagement from the respective opening of the door (I)
- the support means for the frame (3,4) include two rotary shafts (4) which rotate in opposite senses about respective vertical axes each situated in correspondence with one of the panels (2);
- the first of said two shafts (4) constitutes said at least one rotary shaft associated with said actuating device (22), and
- the second of said two shafts (4) has associated with it a transmission rod (25) which moves longitudinally as a result of the rotation of the first shaft (4) between said first (X′) and the said second (X″) angular positions and a drive-transmission mechanism (26) of reversing type which transforms the longitudinal translation of said transmission rod (25) into a rotation of the second shaft (4) in the opposite sense from the rotation of the first shaft (4) having the associated actuation device (22).

FIG. 1

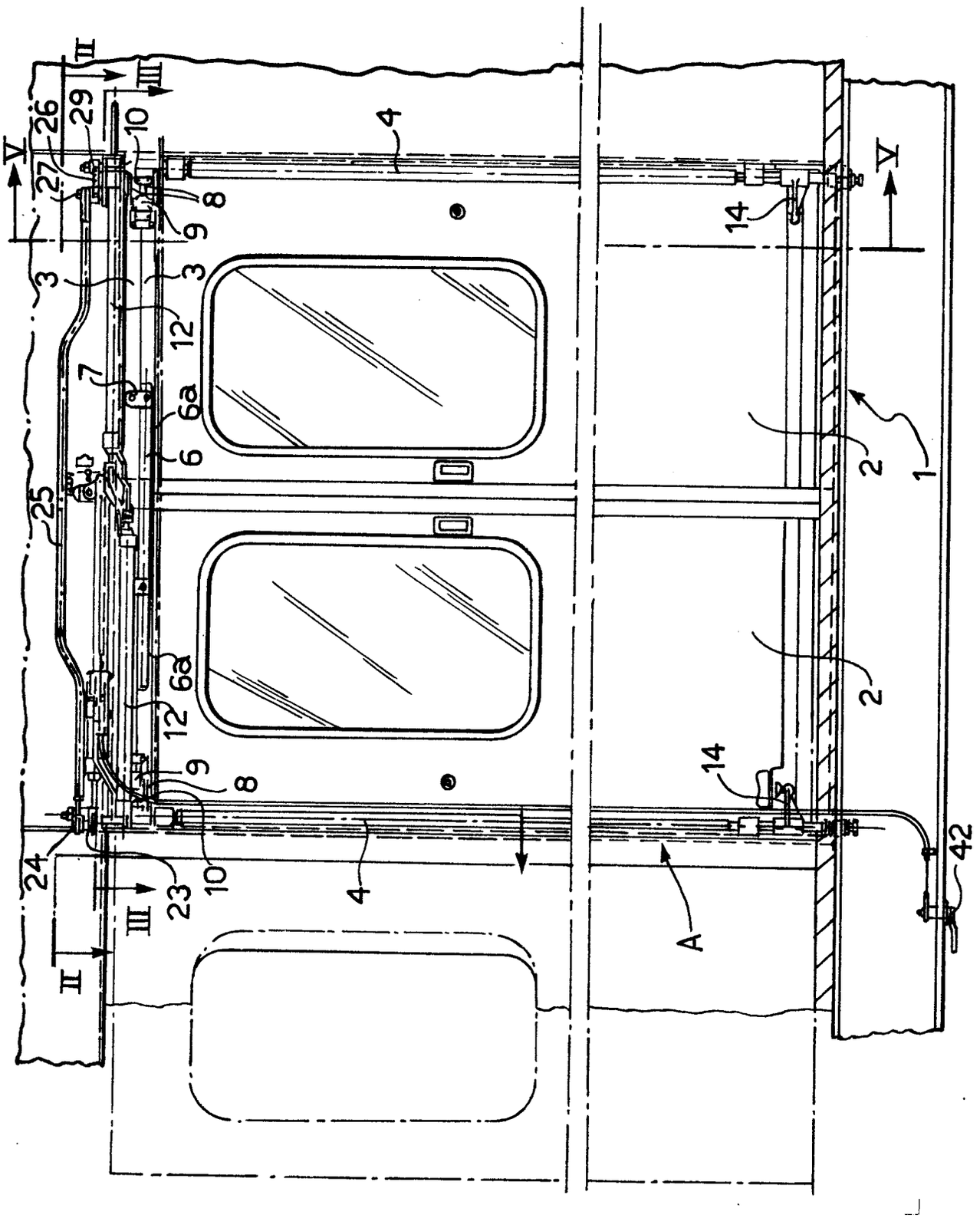

FIG. 2

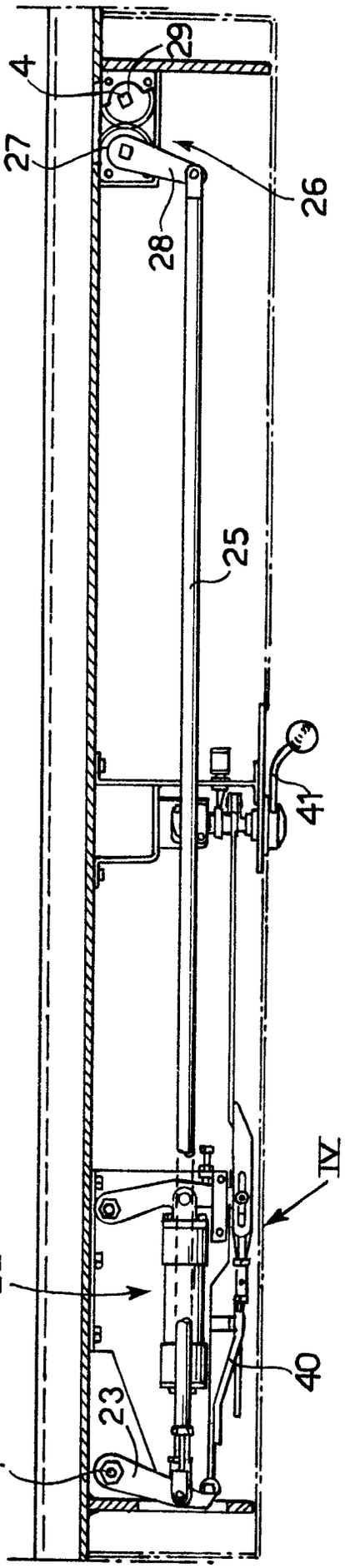
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FIG. 3

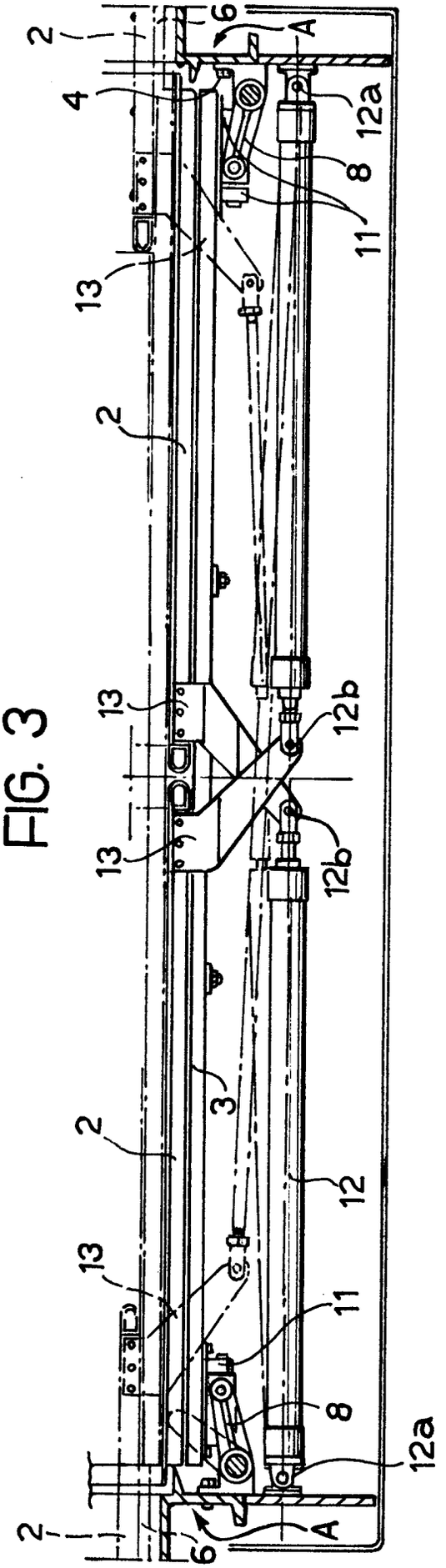
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FIG. 4

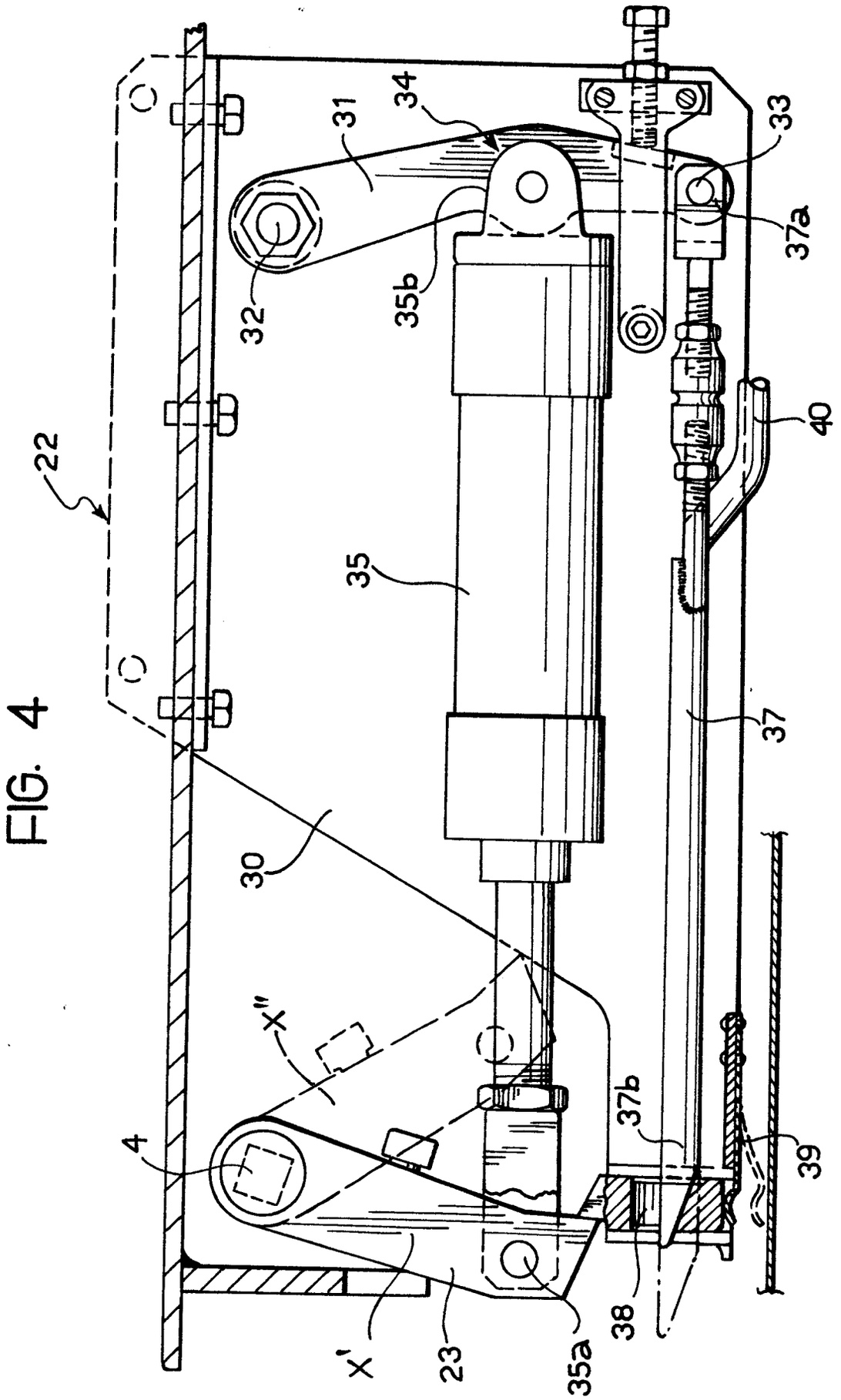

FIG. 5