(19) Europäisches Patentamt
European Patent Office
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(11) **EP 2 281 991 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.02.2011 Bulletin 2011/06

(21) Application number: **09166878.0**

(22) Date of filing: **30.07.2009**

(51) Int Cl.:
E05F 1/00 *(2006.01)* ***E05F 1/02*** *(2006.01)*
E05F 5/00 *(2006.01)* ***E05D 15/06*** *(2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **Sliding fire door with electromechanical arrest**

(57) A sliding fire door (50) comprising: a door panel (32) that can move both ways along a guideway (12) horizontal and parallel to the plane of the door panel (32) between a closed position and a maximum opening position, two or more suspension rollers (14) facilitating the movement of the door panel (32) along the guideway (12), stored-energy closure means (11) that move the door panel (32) to the closed position when it is left open and means of constraint (10.1; 10.2) that hold the door panel (32) in an open position if subjected to temperatures below a set value. The means of constraint (10.1; 10.2) are independent of the closure means (11) and comprise: at least one kinematic mechanism (25; 35) cooperating with at least one roller (14) also carried by the door panel (32) and able to roll along a guidesurface (12) following the movement of the door panel (32), the kinematic mechanism (25; 35) being in one of two conditions, a first condition in which rotation of the roller (14) or rollers cooperating with it is only blocked in the direction of rotation corresponding to the closing movement of the door panel (32), thereby generating sliding friction between this roller (14) or these rollers and the respective guidesurface (12) that is able to overcome the action exerted on the door panel (32) by the closure means (11) and a second condition in which the said roller (14) or said rollers are free to rotate in both directions, and electromagnetic means (31; 51) that, when electrically powered, act on the kinematic mechanism (25; 35) to keep it in its first condition, whilst when the power supply is interrupted, in particular following detection of a fire, their action on the kinematic mechanism (25; 35) ceases, the latter consequently finding itself in its second condition, so that the door closes under the action of the closure means (11).

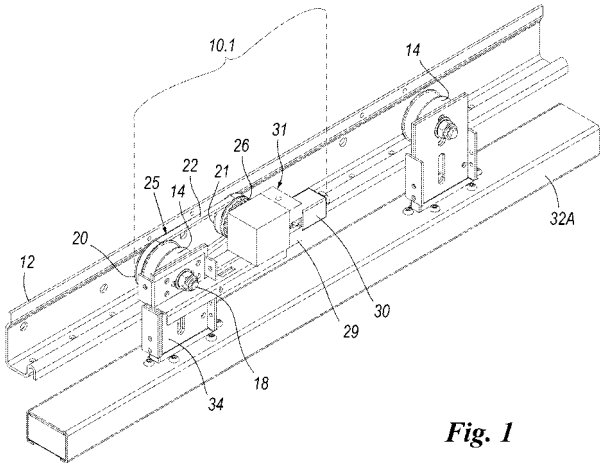

Fig. 1

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Description

[0001] The present invention concerns sliding fire doors and, in particular, those of large dimensions.

[0002] Basically, sliding fire doors comprise fixed parts (suspension guide, fixed labyrinths, doorstop profile and/or counterweight box) that delimit the opening in the relevant wall that the door is destined to close and a door panel that can slide along a suspension guide, horizontal and parallel to the plane of the door panel, between a closed position and a position of maximum opening. The sliding of the door panel on said guide is made possible by the door panel resting upon it by means of two or more rollers rotationally fixed to the door panel, which transform sliding friction into rolling friction.

[0003] In the case of fire, the doors must automatically close from whatever position they are in. If this situation arises, it is important that the device that handles door closure functions under all conditions, especially when there is a blackout. To that end, stored-energy closure devices (such as counterweight, spring and mixed means) are used, which move the door panel to the closed position if it has been left free. It is therefore necessary to provide means of constraint that cancel the action said closure means in order to keep the door panel in the open position in non-emergency conditions (no fire or events ascribable to a fire). Traditionally, thermal-fuse-based means of constraint have been used that, if subjected to a temperature above a set value, following a fire, release the door panel so that the door closes automatically because the door panel remains subjected to just the action of said closure means. Thermal-fuse-based means of constraint allow the door panel to go automatically to the closed position, even starting from a partially open position (a position other than that of maximum opening). In the case of counterweight closure means, one part of the thermal fuse is fixed to said guide and the other is connected, via specially provided return pulleys, to the counterweight. The alloy that joins the two parts that form the thermal fuse melts when it reaches a certain set temperature, freeing the two parts so that the end connected to the pulling cable engages the door panel and, thanks to the accumulated energy, pulls it shut.

[0004] To prevent the door panel of the door arriving in the closed position at a potentially dangerous speed (especially if the door is very large), door panel speed control means are provided, which are not dealt with herein as they lie outside the present invention.

[0005] The fact of not being obliged to fully open a sliding fire door for it to perform its task constitutes a non-inconsequential advantage, particularly in the case of very large doors, for which it is sufficient for most of the time that they are only partially open, with the further advantage of having more rapid closure in the case of fire.

[0006] So far, the recourse to said fuse-based means of constraint has been universally accepted by the market, also because they are very cheap and have the practical advantage of being supplied directly by the manufacturer of the fire door and of being mounted together with the latter at no extra cost.

[0007] However, this solution presents serious drawbacks to the point of even compromising the functionality of the sliding fire door to which it has been applied. The first of these is related to the positioning of the thermal fuse, which due to its characteristics must be fixed to the guide and therefore in one of the two environments. If the fire develops in the other environment, especially if the door is very large (and therefore with a large opening to protect), it may happen that the fire is able to propagate to the first environment, via the open door, before the fuse is affected by the fire and thus allows closure of the door. The problem of where to place the fuse with respect to the door panel arises already with a small-sized door, but even more so with a large one. For example, if the fuse is positioned, as often happens, at the end of the door (the end of the guide farthest away from the doorstop end), it is easy to understood that fire, especially for very large doors (nowadays fire doors that are 40 m wide and able to arrive to heights of 6 m are not rare), could have all the time to pass from one room to the other through the open fire door before the fuse melts to make to door close. In addition to the problems of placement in one of the two environments and the positioning on the guide at a distant point from the opening to be protected, it has to be said that, due to the way it is made, it is not possible to check the thermal fuse as a test would be irreversible.

[0008] It should also be borne in mind that the fuse might not function because it is unintentionally shielded by various objects and that even air currents can contribute to it not working.

[0009] For some time it has been appreciated that to overcome these serious drawbacks (for which the fire door might not perform its task with sufficient rapidity, with the serious consequences that this entails), it is of fundamental importance to distinguish the fire compartmentation of a building from the detection of a possible fire that might start within it. In particular, an accurate analysis of the site is necessary, after which an expert in the field can appreciate how to detect a fire and, in particular, in which and how many points of the building (normally, not just close to the door, as instead happens compulsorily if the above-described fuse-based solution is used).

[0010] As an alternative to thermal-fuse-based means of constraint, electromagnet-based means of constraint have been subsequently introduced on the market that, when electrically powered, allow the action exerted on the door panel by the stored-energy closure means (such as counterweight closure means) to be overcome, in this way holding the door panel of the door only at its maximum opening position, the power supply being interrupted (thereby freeing the door panel) when one or more temperature sensors, placed in appropriate positions (therefore, not necessarily close to the door), detect a temperature higher than a set value. In this case as well, counterweight closure means move the door panel to its

closed position if the action of the electromechanical means of constraint ceases. In the case of counterweight closure means, the electromagnet-based means of constraint are fixed to the guide, while the feedbacks are integral with the door panel and the associated pulling cable is secured with one end to the door panel and the other, by means of a suitable return pulley, to the counterweight.

[0011] It should first be said that, although more rational and decidedly more reliable, this solution is not very successful because, apart from not allowing the door to kept partially open, it is more complicated and decidedly more expensive that the fuse-based solution, especially if a number of temperature sensors located in different positions is planned. This can involve the realization of a full-blown fire-protection system, which envisages a command and control unit that acquires temperature readings detected by these sensors and interrupts the power supply to the electromagnet-based means of constraint when at least one of the sensors associated with a given door detects a temperature higher that a set value.

[0012] As stated above, sliding fire doors with electromagnet-based means of constraint have a drawback with respect to the fuse-based solution. In particular, only two positions for the door panel of the door are possible, namely the closed position and the fully open one. That is to say that no intermediate positions of partial opening are possible.

[0013] Until now (although things are under development), as there are no regulations that prevent its use, the user (who is not necessarily competent on such matters) is certainly not induced to adopt the solution employing electromagnet-based means of constraint, even though they provide a significantly higher level of safety, due to their higher cost and for the inability to keep the door in a partially open position.

[0014] An object of the present invention is to provide a sliding fire door that is not of the thermal fuse type and which also allows the partial opening of the door.

[0015] This objective is achieved thanks to the sliding fire door according to the present invention, **characterized in that** the means of constraint are independent of the closure means and comprise:

at least one kinematic mechanism carried by the door panel and cooperating with at least one roller also carried by the door panel and able to roll along a guidesurface following the movement of the door panel, the kinematic mechanism being in one of two conditions, a first condition in which rotation of the roller or rollers cooperating with said kinematic mechanism is only blocked in the direction of rotation corresponding to the closing movement of the door panel, thereby generating sliding friction between this roller or these rollers and the respective guidesurface that is able to overcome the action exerted on the door panel by the closure means, and a second condition in which the said roller or said rollers are free to rotate in both directions;

electromechanical means that, when electrically powered, act on the kinematic mechanism to keep it in its first condition, whilst when the power supply is interrupted, in particular following detection of a fire, their action on the kinematic mechanism ceases, the latter then consequently finding itself in its second condition, for which the door closes under the action of the closure means.

[0016] It should be noted that such a sliding fire door could also be partially open, though still be able to close itself in the case of fire even if the door panel is in a partially open position.

[0017] The roller or rollers with which said kinematic mechanism cooperates can expediently be the same suspension rollers of the door panel on said guideway, or could also be specially provided rollers that, for example, make contact with the floor, provided that when the kinematic mechanism is in its first condition they allow sliding friction to be generated with the associated guidesurface that is able to overcome the force exerted by the closure means on the door panel.

[0018] It should also be noted that while the electromagnet-based means of constraint are fixed, directly or indirectly, to the counterweights of known sliding fire doors with counterweight closure means, in the case of the present invention said electromechanical means are carried by the door panel and do not have any connection with the closure means (in particular, with the counterweight).

[0019] The invention shall be more easily understood from the following description of some embodiments provided by way of example. This description refers to the enclosed drawings, where:

Fig. 1 is a perspective view of a first embodiment of the electromechanical means of constraint applied to one of the suspension rollers of a sliding fire door according to the present invention, a section of the guideway and a section of the door panel's upper cross-beam also being shown in the figure,

Fig. 2 is an exploded perspective view from a different viewpoint,

Fig. 3 is a vertical cross-section through the axis of rotation of the suspension roller affected by the electromechanical means of constraint, the figure also showing the top part of the door panel, the part of the framework to which the guide is fixed and one of the mounting brackets of the cover guard,

Fig. 4 is a vertical cross-section through the axis of rotation of the cogwheel shown in Figs. 1 and 2,

Fig. 5 is a similar perspective view to that of Fig. 1, but regards a second embodiment of the electromechanical means of constraint,

Fig. 6 is an exploded perspective view from a different viewpoint, and

Fig. 7 is a perspective view of a sliding fire door according to the present invention, in a partially open position.

[0020] The electromechanical means of constraint in Figs. 1-4 have been indicated as a whole by reference numeral 10.1, In this specific case, they cooperate with just one of the suspension rollers 14 (two are shown Figs. 1 and 2), which can run along the guideway 12. As can be seen in Fig. 3, the guideway 12 is fastened to a fixed structure in the conventional manner (in this specific case, a horizontal beam 16 that delimits the top of the door). The same figure also shows the top part of the door panel 32 of the door, the top edge of which is formed by a metal crossbeam that, for simplicity, is not shown in Figs. 3 and 4, but can be seen in Figs. 1 and 2 where it is indicated with reference numeral 32A. In Fig. 3, it can be seen that the sliding roller 14 cooperates with the means of constraint 10.1 and is idle-mounted (via a ball bearing) on a horizontal hub 18, fixed to the door panel 32 via a bracket 34 and perpendicular to the latter. This sliding roller 14 is rotationally integral (Fig. 3) with a first coaxial pulley 20 cooperating with a belt 22 that also cooperates with a second pulley 21. The latter is mounted on a second horizontal hub 24 carried in an idle manner (via two ball bearings, shown in Fig. 4) by the bracket 34 fastened to the crossbeam 34A of the door panel 32. It should be noted that the second pulley 21 is mounted on the second hub 24 via a one-way bearing 23 that only allows rotation of the second pulley 21 in one direction with respect to the hub 24 and, more precisely, in the direction corresponding to the opening direction of the door. As shall be clear from the following, this also allows the door to be opened just partially and to keep the door in this partially open position.

[0021] A coaxial cogwheel 26 is fitted on the second hub 24 (Fig. 4). The assembly formed by the first pulley 20, the belt 22, the second pulley 21 with the associated one-way bearing 23 and the cogwheel 26 is, in substance, said kinematic mechanism, which is indicated as a whole with reference numeral 25 (Fig. 1).

[0022] In Fig. 2, it can be seen that a pawl 28 is also provided that can move between two positions, more precisely, a position that we shall call blocked, in which the pawl 28 interferes with the teeth of the cogwheel 26, consequently keeping the door panel 32 blocked in the position it is in (in particular, totally, but also partial open), and a position of non-interference in which the pawl 28 is retracted (does not interfere with the teeth of the cogwheel 26), for which the door panel 32 is left free to move and it closes under the action of said conventional counterweight means (shown in Fig. 7 and indicated by reference numeral 11) or other closure means of the stored-energy type. The pawl 28 is operated via a conventional mechanism 29 controlled by a conventional electromechanical device 30 and, in particular, is in its blocking position when the electromechanical device 30 is electrically powered, while if the power supply is interrupted, the pawl 28 passes automatically to its non-interference position thanks to a return spring (not shown). The assembly of the pawl 28, the mechanism 29 and the electromechanical device 30 constitute that which was previously called electromechanical means and indicated as a whole by reference numeral 31 in Fig. 1. Therefore, when these electromechanical means are electrically powered, rotation of the corresponding suspension roller 14 is blocked because the friction between roller 14 and guideway 12 is transformed from rolling to sliding, with the result that the counterweight means are no longer able to overcome the opposing force due to this sliding friction.

[0023] A conventional cover guard, with which guides are conventionally equipped, is envisaged, for which a support bracket, indicated by reference numeral 36, is shown in Figs. 3 and 4.

[0024] Figs. 5 and 6 show a second embodiment, indicated as a whole by reference numeral 10.2, of the electromechanical means of constraint of the sliding fire door according to the present invention. In these figures, the same elements of Figs. 1-4 are indicated by the same reference numerals. Means of constraint 10.2 are different from means of constraint 10.1 because the hub 24 on which the second pulley 21 is mounted, via an associated one one-way bearing 23, has a coaxial enlargement 38. The assembly of the first pulley 20, the belt 22, the second pulley 21 with the associated one-way bearing 23 and the enlargement 38 constitute, in substance, said kinematic mechanism, indicated as a whole by reference numeral 35 in Fig. 5. The enlargement 38 is surrounded by a clamping shoe 40 internally lined with a material that increases the sliding friction when it makes contact with the lateral surface of the enlargement 38. The two ends 41 of the clamping shoe 40 can be moved closer together by the elastic deformation of the latter so as to grip the enlargement 38 and thus block rotation of the hub 24. Due to the presence of the one-way bearing 23, the door panel 32 can therefore only move in the opening direction of the door, and so the door panel remains, for example, in the partially open position it finds itself in, without it being possible to close it, although it is still possible to open it further.

[0025] Moving the two ends 41 of the clamping shoe 40 closer together is controlled by a conventional gripper unit 43, the two jaws 42 of which are operated via a conventional electromechanical device 44. In particular, the jaws 42 move closer together and tighten the clamping shoe 40 when power is supplied to the electromechanical device 44. The assembly of the clamping shoe 40, the gripper unit 43 and the electromechanical device 44 form what has been previously called the electromechanical means and indicated as a whole by reference numeral 51 in Fig. 5. When power to the electromechanical means 51 is interrupted, the jaws 42 move apart due to the presence of a return spring (non shown) and, thanks to the elasticity of the clamping shoe 40, the two ends 41 of the latter also move apart, freeing the enlargement 38 and

thus the hub 24, and so the door can close under the action of the conventional counterweight closure means such as those indicated by reference numeral 11 in Fig. 7. In fact, this figure shows a sliding fire door according to the present invention, indicated as a whole by reference numeral 50, which allows the closing of an opening 52 in a wall 54. As can be seen, the related door panel 32 is suspended from a guideway 12, fastened to the wall 54, via two suspension rollers 14, one of which (the one on the left) cooperates with a kinematic mechanism according to the door of the present invention, for example, of type 10.1 or 10.2.

[0026] To a mechanical expert, and taking into account the above-specified fundamental characteristics of the fire door according to the present invention, it is evident that the kinematic mechanism and the associated electromechanical means of constraint can be embodied in different way to that described above, yet still remain within the scope of protection present invention.

[0027] It is also evident from the foregoing that the presence or absence of an electric power supply to the electromechanical means is controlled via a command and control unit that is part of an opportunely designed fire-protection system equipped with temperature sensors located in suitable points of the building as established by the designer of this system.

[0028] Finally, it should be noted that in cases where it serves to obtain sufficient sliding friction force to overcome the force exerted on the door panel by the counterweight closure means, it is possible to provide more than one kinematic mechanism of type 10.1 or 10.2, or a kinematic mechanism that cooperates with more than one roller and, in particular, with more than one of the suspension rollers 14. In this latter case, for example, it is possible to envisage (with reference to Figs. 1 and 2) that the second pulley 21, coaxial with the cogwheel 26, has a double groove for two associated belts, with one cooperating with a first pulley such as pulley 20, integral in rotation with a suspension roller 14, and the other, longer belt, cooperating with another pulley, integral in rotation with another of the suspension rollers that is on the same side of the door panel 32 with respect to the hub 24.

Claims

1. Sliding fire door (50) comprising:

a door panel (32) that can move both ways along a guideway (12), horizontal and parallel to the plane of the door panel (32), between a closed position and a maximum opening position, two or more suspension rollers (14) allowing the movement of the door panel (32) along the guideway (12),

stored-energy closure means (11) that move the door panel (32) to the closed position when it is left unblocked;

means of constraint (10.1; 10.2) that hold the door panel (32) in an open position if subjected to temperatures below a set value;

characterized in that the means of constraint (10.1; 10.2) are independent of the closure means (11) and comprise:

at least one kinematic mechanism (25; 35) carried by the door panel (32) and cooperating with at least one roller (14) also carried by the door panel (32) and able to roll along a guidesurface (12) following the movement of the door panel (32), the kinematic mechanism (25; 35) being in one of two conditions, a first condition in which rotation of the roller (14) or rollers cooperating with said kinematic mechanism is only blocked in the direction of rotation corresponding to the closing movement of the door panel (32), thereby generating sliding friction between this roller (14) or these rollers and the respective guidesurface (12) that is able to overcome the action exerted on the door panel (32) by the closure means (11), and a second condition in which the said roller (14) or said rollers are free to rotate in both directions, and

electromechanical means (31; 51) that, when electrically powered, act on the kinematic mechanism (25; 35) to keep it in its first condition, whilst when the power supply is interrupted, in particular following detection of a fire, their action on the kinematic mechanism (25; 35) ceases, the latter consequently finding itself in its second condition, so that the door closes under the action of the closure means (11).

2. Sliding fire door (50) according to claim 1, in which the roller or rollers cooperating with a kinematic mechanism (25; 35) are suspension rollers (14) of the door panel (32).

3. Sliding fire door (50) according to claim 2, in which the kinematic mechanism (25) comprises a first pulley (20) integral in rotation with the associated suspension roller (14) idle-mounted on a first horizontal hub (18) fixed to the door panel (32) and perpendicular to the latter, the first pulley (20) cooperating with a belt (22) that also cooperates with a second pulley (21) mounted, via a one-way bearing (23), on a second horizontal hub (24) carried in an idle manner by the door panel (32) and perpendicular to the latter, the one-way bearing (23) only allowing rotation of the second pulley (21) in the direction corresponding to the opening of the door, a coaxial cogwheel (26) being fitted on the second hub (24), and the electro-

mechanical means (31) comprising a pawl (28) that can move between two positions, one of interference with the cogwheel (26) and the other of non-interference, the pawl (28) being operated by an electromechanical device (30).

4. Sliding fire door (50) according to claim 2, in which the kinematic mechanism (35) comprises a first pulley (20) integral with the associated suspension roller (14) and idle-mounted on a first horizontal hub (18) fixed to the door panel (32) and perpendicular to the latter, the first pulley (20) cooperating with a belt (22) that also cooperates with a second pulley (21) mounted, via a one-way bearing (23), on a second horizontal hub (24A) carried in an idle manner by the door panel (32) and perpendicular to the latter, the one-way bearing (23) only allowing rotation of the second pulley (21) in the direction corresponding to the opening of the door, the second hub (24A) having a coaxial enlargement (38), and the electromechanical means (51) comprising an electromechanical device (44) for moving the two ends (41) of an elastically deformable clamping shoe (40) close to each other when electrically powered, so as to grip the enlargement (38) and in this way block the rotation of the second hub (24A).

5. Sliding fire door according to claim 4, in which the electromechanical device (44) is fitted with a gripper mechanism (51) equipped with two jaws (42) that move the ends (41) of the clamping shoe (40) closer together when the electromechanical device (44) is electrically powered.

6. Sliding fire door according to claims 4, in which the inner surface of the clamping shoe (40) is lined with a lining material (46) able to develop sliding friction forces when pressed against the surface of the enlargement (38).

Amended claims in accordance with Rule 137(2) EPC.

1. Sliding fire door (50) comprising:

a door panel (32) that can move both ways along a guideway (12), horizontal and parallel to the plane of the door panel (32), between a closed position and a maximum openings position, two or more suspensions rollers (14) allowing the movement of the door panel (32) along the guideway (12),
stored-energy closure means (11) that move the door panel (32) to the closed position when it is left unbtocked;
means of constraint (10.1; 10.2) that hold the door panel (32) in an open position if subjected to temperatures below a set value; the means of constraint (10.1; 10.2) are independent of the closure means (11) and comprise:
at least one kinematic mechanism (25; 35) carried by the door panel (32) and cooperating with at least one roller (14) also carried by the door panel (32) and able to roll along a guidesurface (12) following the movement of the door panel (32), the kinematic mechanism (25; 35) being in one of two conditions, a first condition in which rotation of the roller (14) or rollers cooperating with said kinematic mechanism is only blocked in the direction of rotation corresponding to the closing movement of the door panel (32), thereby generating sliding friction between this roller (14) or these rollers and the respective guidesurface (12) that is able to overcome the action exerted on the door panel (32) by the closure means (11), and a second condition in which the said droller (14) or said rollers are free to rotate in both directions, and
electromechanical means (31; 51) that, when electrically powered, act on the kinematic mechanism (25; 35) to keep it in its first condition, whilst when the power supply is interrupted, in particular following detection of a fire, their action on the kinematic mechanism (25; 35) ceases, the latter consequently finding itself in its second condition, so that the door closes under the action of the closure means (11), mechanism (25) comprises a first pulley (20) integral in rotation with the associated suspension roller (14) idle-mounted on a first horizontal hub (18) fixed to the door panel (32) and perpendicular to the latter, the first pulley (20) cooperating with a belt (22) that also cooperates with a second pulley (21) mounted, via a one-way bearing (23), on a second horizontal hub (24) carried in an idle manner by the door panel (32) and perpendicular to the latter, the one-way bearing (23) only allowing rotation of the second pulley (21) in the direction corresponding to the opening of the door, the electromechanical means (31; 51) comprising on electromechanical device (30;44) which, when electrically powered, allow to block the rotation of the second hub (24; 24A).

2. Sliding fire door according to claim 1, in which a coaxial cogwheel (26) being fitted on the second hub (24), and the electromechanical means (31) comprising a pawl (28) that can move between two positions, one of interference with the cogwheel (26) and the other of non-interference, the pawl (28) being operated by an electromechanical device (30).

3. Sliding fire door according to claim 1, in wihich the second hub (24A) has a coaxial enlargement (38), and the electromechanical means (51) comprises an

electromechanical device (44) for moving the two ends (41) of an elastically deformable clamping shoe (40) close to each other when electrically powered, so as to grip the enlargement (38) and in this way block the rotation of the second hub (24A).

4. sliding fire door according to claim 3, in which the electromechanical device (44) is fitted with a gripper mechanism (51) equipped with two jaws (42) that move the ends (41) of the clamping shoe (40) closer together when the electromechanical device (44) is electrically powered.

5. Sliding fire door according to claim 3, in which the inner surface of the clamping shoe (40) is lined with a lining material (46) able to develop sliding friction forces when pressed against the surface of the enlargement (38).

6. Sliding fire door (50) according to claim 1, in which the roller or rollers cooperating with a kinematic mechanism (25; 35) are suspension rollers (14) of the door panel (32).

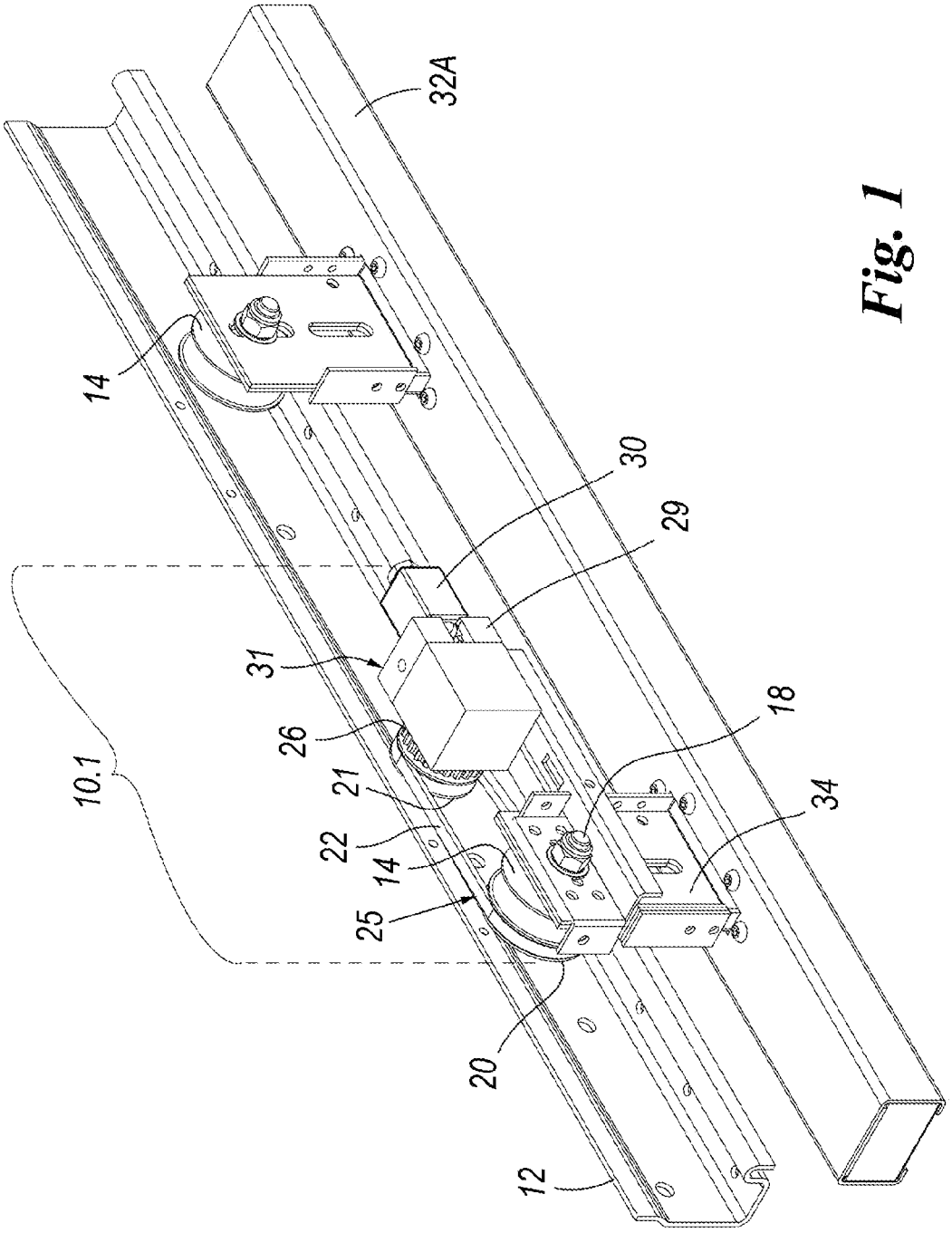

Fig. 1

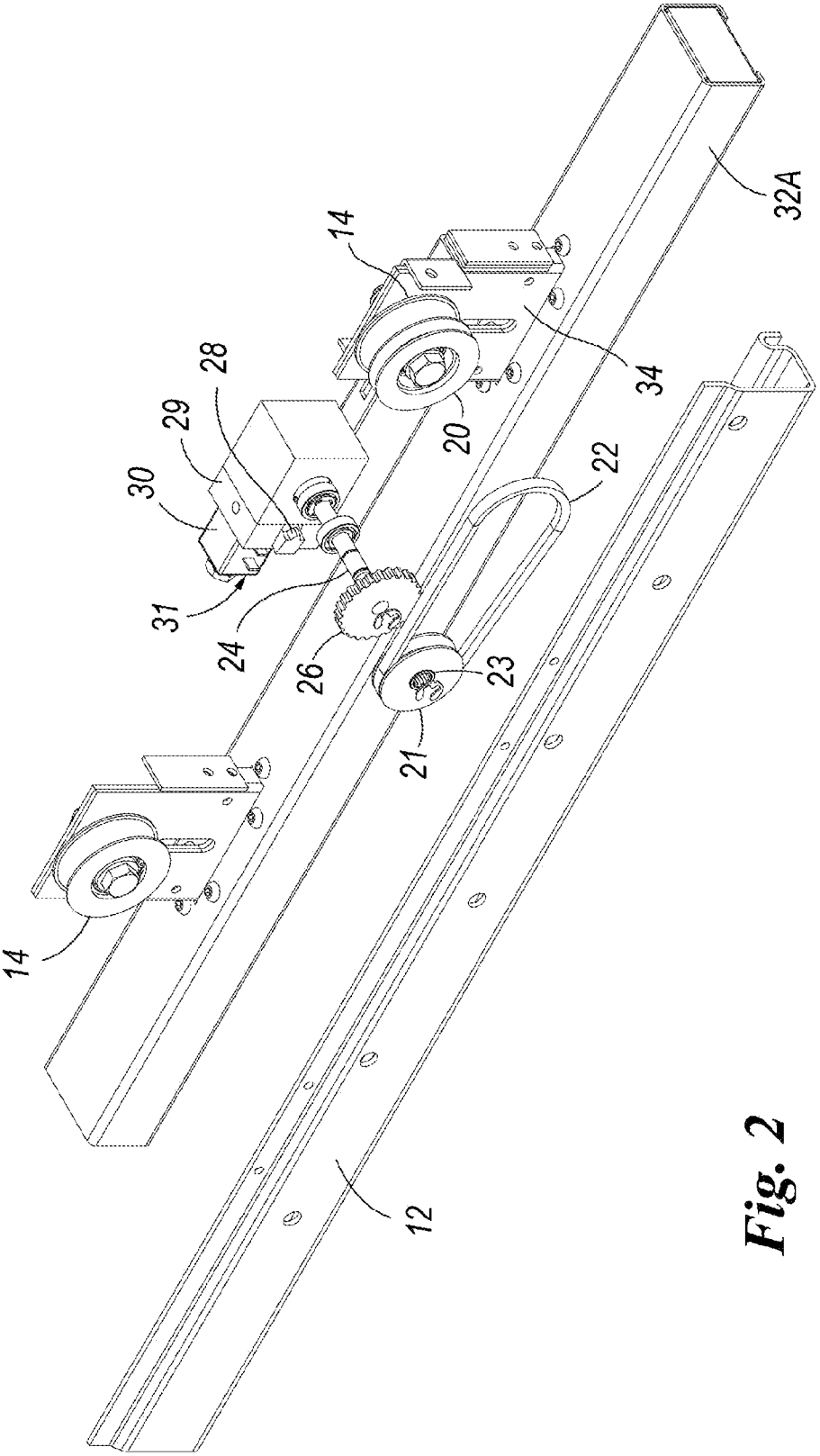

Fig. 2

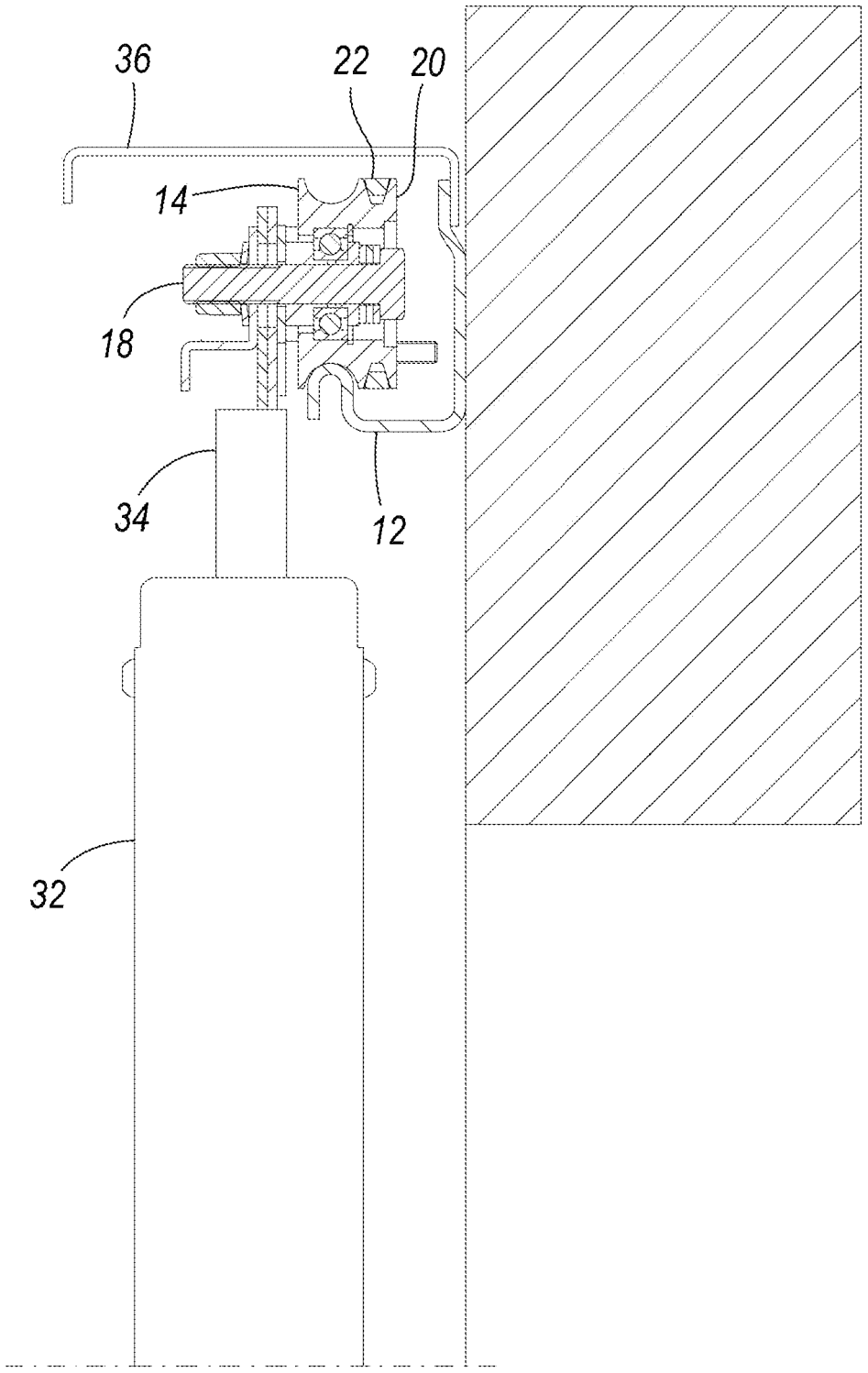

Fig. 3

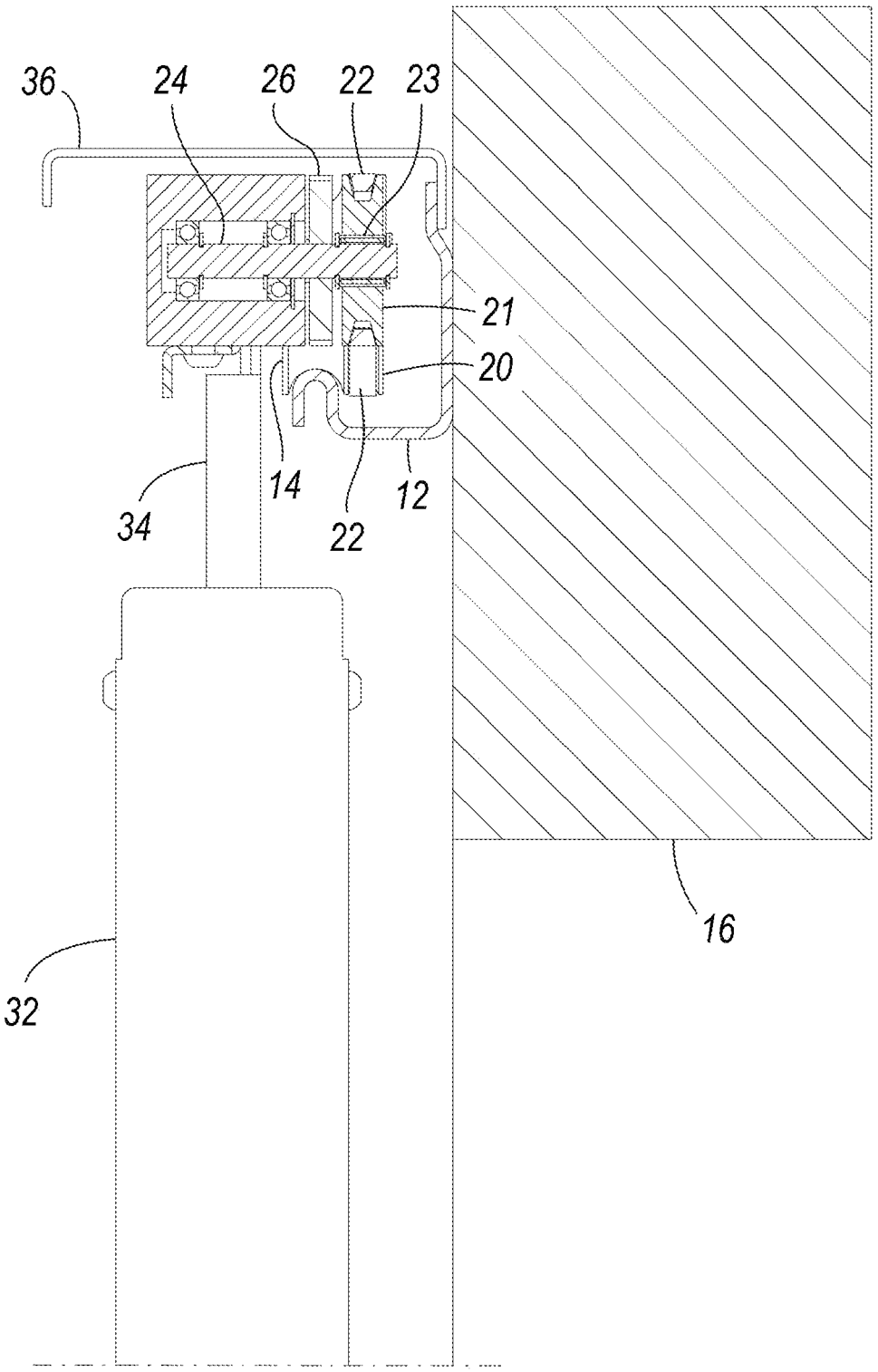

Fig. 4

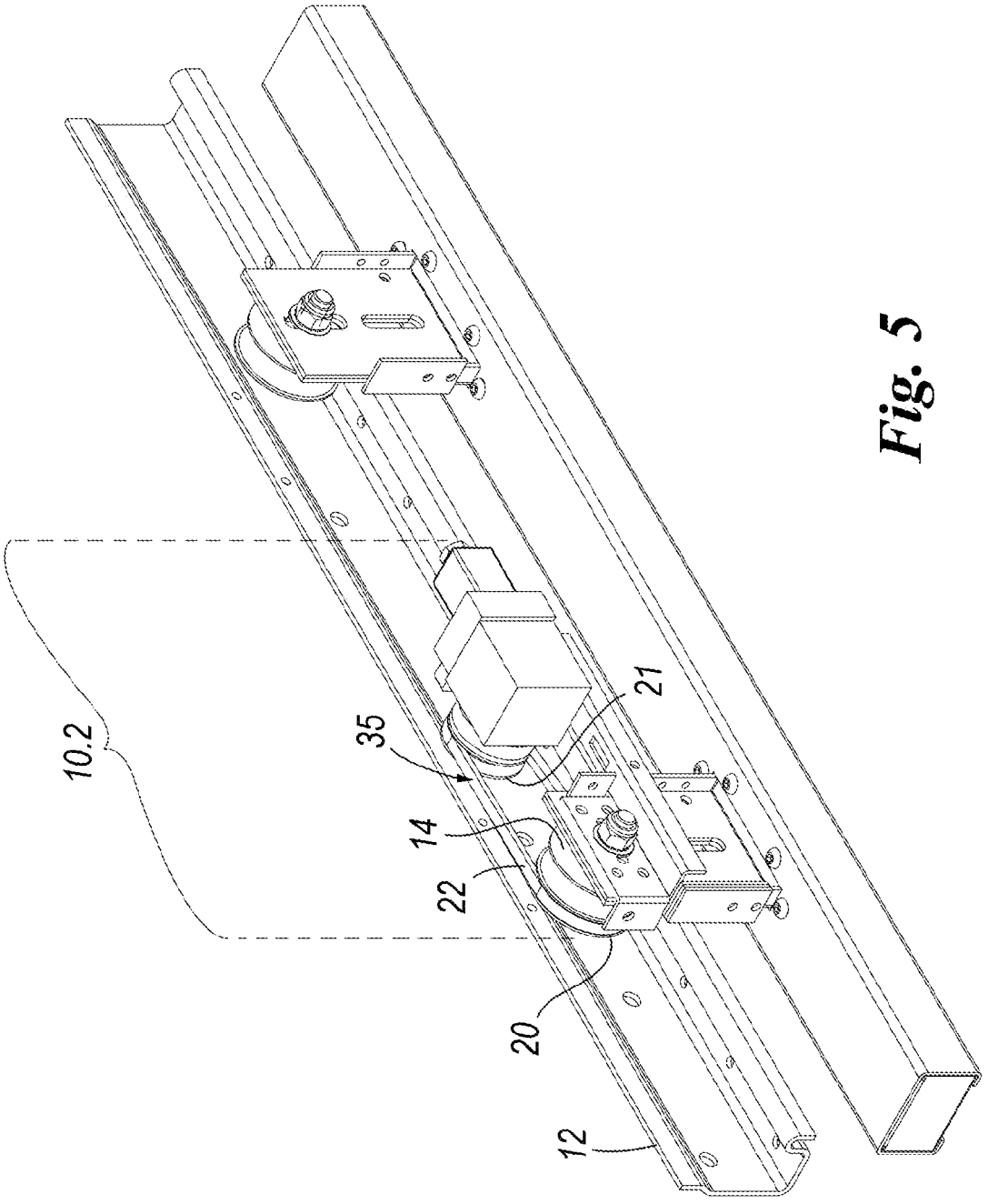

Fig. 5

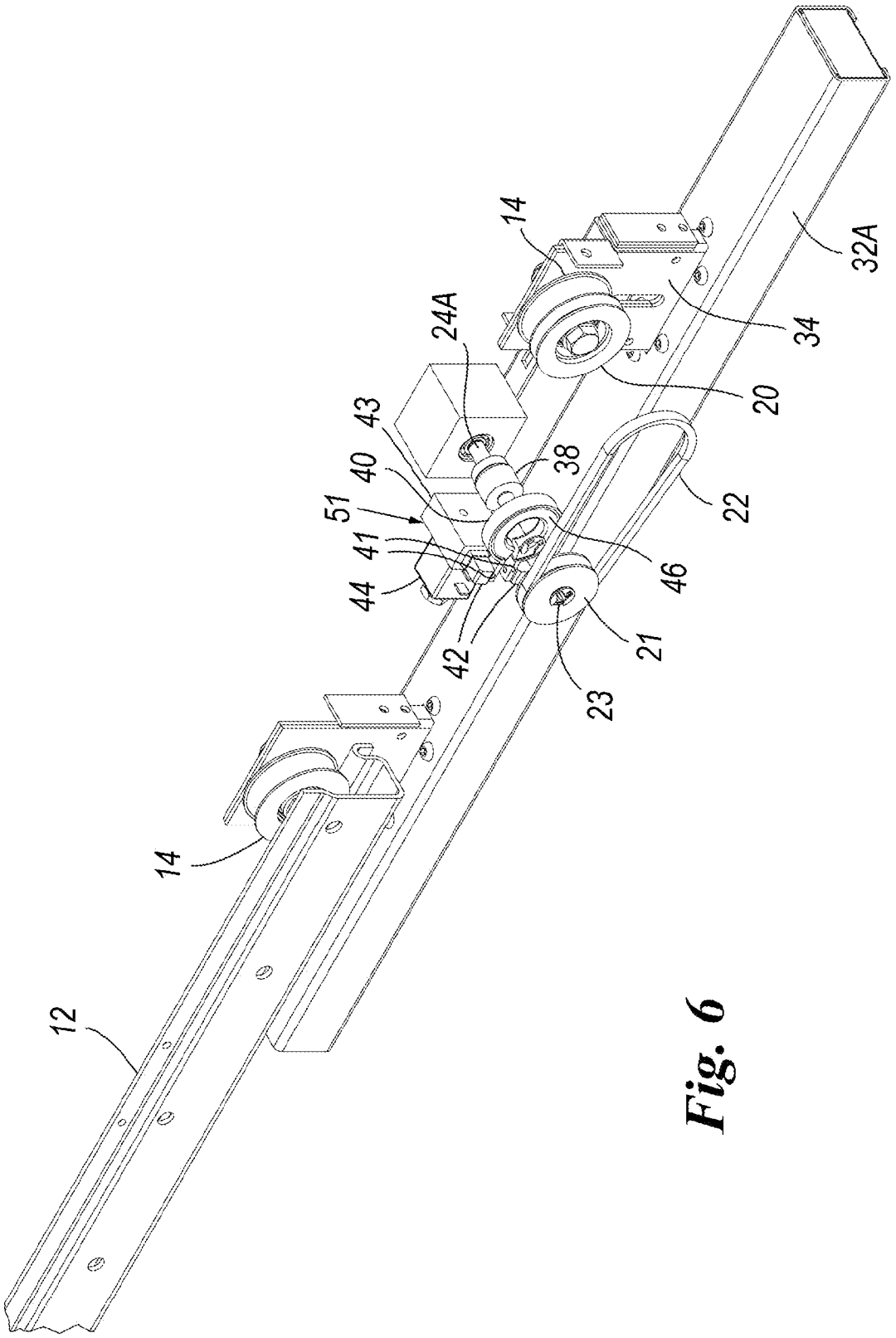

Fig. 6

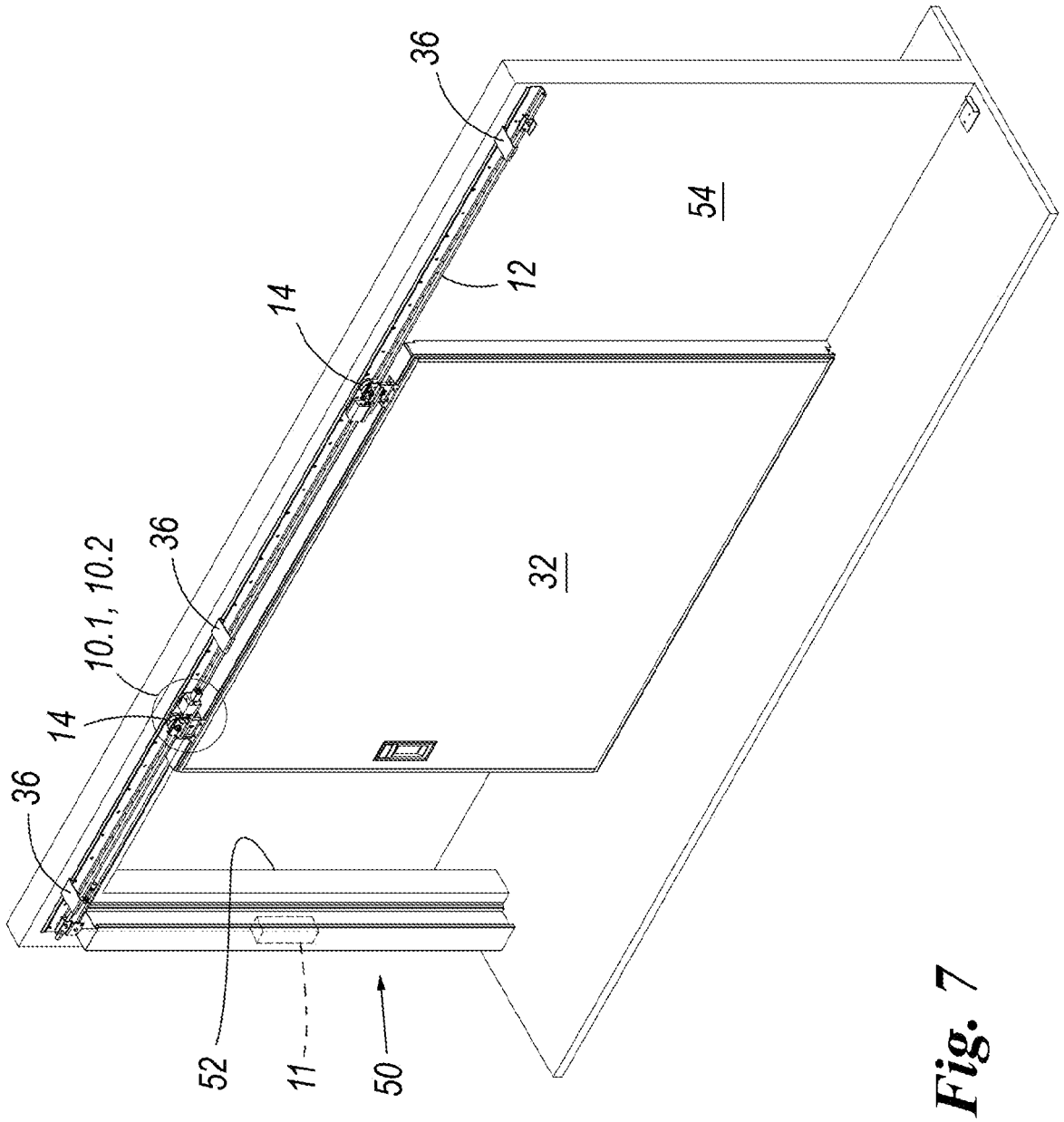

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
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