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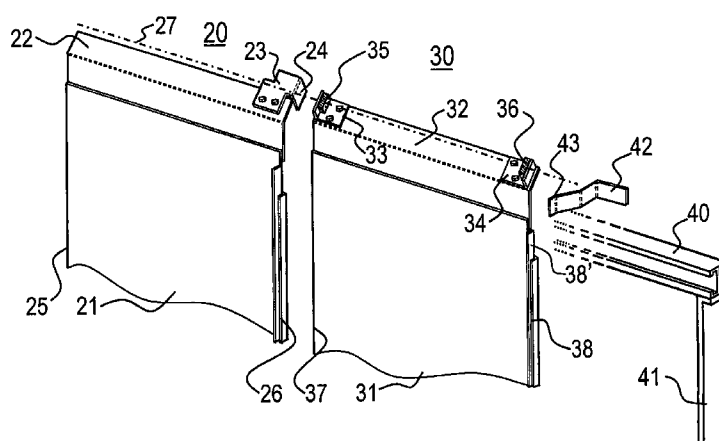


Fig. 3

(57) Abstract: A drive system for an elevator door includes at least two subassemblies (20, 30) and a releasable engagement device between the subassemblies. A first subassembly (20), which includes a first panel (21) affixed to a first trolley (22), moves between first and second stops (41, 44) along a track (40) that extends across a doorway (50). A second subassembly (30), which includes a second panel (31) affixed to a second trolley (32), also moves along the track (40). The releasable engagement device between the subassemblies (20, 30) includes a first engagement member (24, 60) affixed to the first trolley (22) and a second engagement member (35, 36, 70) affixed to the second trolley (32). The engagement members are configured to be coupled by a force of mutual attraction and/or mechanical interaction of such first and second engagement members when the trolleys (22, 32) are impelled against each other. The engagement members are configured to be decoupled by a force that is configured to overcome the force of mutual attraction and/or mechanical interaction.

## SYSTEM AND METHOD FOR DRIVING ELEVATOR DOORS

BACKGROUND5 Field of the invention

The present invention refers to elevator door systems and more particularly, to drive mechanisms for doors made of panels that move horizontally in the same direction for opening and closing the access doorway to the elevator car.

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Summary of the state of the art

Among the most commonly used systems in elevator doors are those that have at least two panels moving in the same direction on parallel paths, each panel having a front edge and a back edge, as well as a header that is  
15 fixed to a support trolley that moves along a track to effect the opening and closing of the door. The width of each panel usually equals half the opening of the access doorway. In the closed position, the first panel has its front edge positioned substantially coincident with the first column of the doorway, and its back edge approximately coincident with the front edge of the second panel. The  
20 back edge of the latter, in turn, is positioned substantially coincident with the second column.

In conventional systems, the opening cycle includes movement of the panels in the same direction, to one side of the doorway. In this operation,  
25 the first panel moves away from the first column toward the second column, the movement of the second panel being in the same direction, i.e., also toward the

second column. At the end of this cycle, the front edges of both panels are in approximately coincident position with the second column, leaving the opening of the access doorway clear between the elevator car and the landing of the floor where it is stopped. As it happens, then, the path traveled by the first panel  
5 during the cycles of opening and closing is approximately equal to the opening between the columns that delimit the mentioned doorway, as its front edge will run the entire distance between the columns. On the other hand, the path of the second panel is approximately half that of the first panel, since the movement of its front edge is limited to the distance between the second column and the  
10 center of the doorway.

In most known systems, the panels move simultaneously at different speeds in order to complete their runs at the same time. Thus, the time that the front edge of the first panel takes to travel between columns is equal to  
15 the time needed by the front edge of the second panel to go half that distance. Consequently, both the opening and closing cycles of the first panel move at twice the speed of the second panel, so that the beginning and end of the movement coincide in time for both.

20 There are several systems designed to provide this two-speed drive. For example, U.S. Patent 5,584,365 proposes the use of an independent electromechanical device to drive each panel. One of the advantages of independent movement of the door panels lies in the fact that the kinetic energy of the assembly is reduced by moving the masses of these panels independently  
25 of each other. This allows the speed of closing the door to be increased without exceeding the limits imposed by safety standards with respect to the maximum

kinetic energy allowed. However, the system proposed in this document presents considerable complexity, due to the need for the second electromechanical drive and means to coordinate its actions with those of the first electromechanical drive, and this complexity is reflected in higher cost.

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A system that uses a single electromechanical drive is shown in patent document WO 2008/034915. In this system, the panels are suspended from their respective headers by two trolleys, referenced as 2 and 3 in Figure 1, which is a reproduction of Figure 1 in WO 2008/034915, and designated “fast”  
10 trolley and “slow” trolley, respectively. An electromechanical drive (not shown) is coupled to fast trolley 2 fitted with wheels 4 that glide on rail 8 of support beam 1 with an asymmetrical “C” section. This fast trolley drives the slow trolley 3 by means of a mechanical coupling made up of two pulleys 5 mounted on the ends of this trolley and a steel cable 12 going around these pulleys to  
15 form a closed link, having an intermediate point of one of its loops locked to a fixed anchor 13, as shown in Figure 1, and in more detail in Figure 2, which is a reproduction of Figure 3 in WO 2008/034915. The opposite loop, in this case, the top one, has an intermediate point attached to a pin 14 that is fixed to the fast trolley (not shown in Figure 2). As illustrated, the pulleys 5 have a peripheral  
20 channel that fits in the rail 9 provided on the lower branch of support beam 1 with “C” section. The arrangement illustrated makes it so that the assembly consisting of trolley 2 and pulleys 5 affixed to it are moved at half the displacement speed of pin 14, that is, of fast trolley 2.

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The apparatus proposed in the patent document is simpler than that described in U.S. 5,584,365. Nevertheless, with time in use, the cable could

unravel or fray, producing an irregular movement of the slow trolley or even stopping it if the cable slips out of one of the pulley grooves or breaks. Also, wear on the axles of the pulleys 5 may be aggravated by the fact of being subjected to forces in two directions, namely, vertical from the weight of the slow panel, and horizontal caused by the necessary tensioning of the cable.

Furthermore, the mechanical linkage between the panels results in an increase in effective mass and, consequently, kinetic energy, giving rise to the need to reduce movement speed in closing the door.

In light of the foregoing, the present invention aims to resolve one or more of the aforementioned issues that pertain to conventional door driving systems.

## SUMMARY

An embodiment of the present invention addresses a drive system of an elevator door. The drive system includes, among other possible things, at least two subassemblies and a releasable engagement device between the subassemblies. The at least two door subassemblies, which move sideways and in the same direction to open and close a doorway, include a first assembly and a second subassembly. The first subassembly comprises a first panel affixed to a first trolley and is configured to move between a first stop and a second stop along a track that extends across the doorway. The second subassembly comprises a second panel affixed to a second trolley and is configured to move along the track. In both the opening and closing operation of the door: (a) a path traveled by the first subassembly in its movement is approximately equal to

the width of the doorway; and (b) a path of the second subassembly is shorter than the path travelled by the first subassembly. The releasable engagement device between the subassemblies includes a first engagement member affixed to the first trolley and a second engagement member affixed to the second trolley. The first and second engagement members are configured to be coupled by a force of mutual attraction and/or mechanical interaction of such first and second engagement members when the trolleys are impelled against each other. The first and second engagement members are configured to be decoupled by application of a force that is configured to overcome the force of mutual attraction and/or mechanical interaction.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only, and are not restrictive of the invention as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become apparent from the following description, appended claims, and the accompanying exemplary embodiments shown in the drawings, which are hereafter briefly described.

Figures 1 and 2 illustrate a prior art system for driving the door, in accordance with patent document WO 2008/034915.

Figure 3 is an exploded view that illustrates the main elements of a first embodiment of a drive system for an elevator door according to the

invention.

Figure 4 shows the elements of the embodiment shown in Figure 3 in positions where they are ready to operate the door, which is in the closed position.

Figures 5-a to 5-e illustrate various stages in a sequence for the elevator door opening and closing operation for the embodiment shown in Figure 3.

Figure 6 is a simplified schematic representation of the elevator door in the embodiment corresponding to Figure 3.

Figures 7-a to 7-e schematically illustrate various stages in a sequence for the elevator door opening and closing operation for the embodiment corresponding to Figure 3 and the schematic of Figure 6.

Figure 8 is a simplified schematic representation of an elevator door in a second embodiment of the invention.

Figures 9-a to 9-f schematically illustrate various stages in a sequence for the elevator door opening and closing operation for the second embodiment of the invention that is diagrammed in Figure 8.

Figure 10 illustrates an attachment detail of magnetic elements according to an embodiment of the invention.

Figures 11-a to 11-f schematically illustrate various stages in a sequence for the door opening and closing operation according to a third embodiment of the invention.

5           Figure 12 illustrates use of a magnetic field generator to facilitate decoupling of the door panels of any one or more of the foregoing embodiments.

Figures 13-a to 13-d illustrate an alternative embodiment of the invention, in which the coupling is provided by mechanical coupling means.

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Figure 14 illustrates the use of a magnetic field generator to facilitate the engagement operation provided by means of the mechanical coupling embodiment of Figures 13-a to 13-d.

15           Figures 15-a to 15-c illustrate in simplified form the use of an alternative mechanical coupling on an elevator door in accordance with another embodiment of the invention.

20           Figures 16-a to 16-g detail operation of the mechanical coupling of the embodiment shown in Figures 15-a to 15-c.

### DETAILED DESCRIPTION

Efforts have been made throughout the drawings to use the same or similar reference numerals for the same or like components.

25

Referring now to Figure 3, the proposed system consists of two

subassemblies 20 and 30. The first subassembly 20 is made up of a first door panel 21 that extends through the height of the access doorway, this panel being suspended by attachment means provided in its header to the first trolley 22 that moves horizontally on track 40. This panel consists of a first vertical edge 25, also known as the front edge and a second vertical edge 26 referred to as the back edge. Similarly, the second subassembly 30 consists of a second door panel 31 that extends through the height of the doorway and that will be suspended by its header to the second trolley 32 that moves horizontally on track 40, on a path parallel to that of the first trolley. This second panel consists of a first vertical edge, or front edge 37 and a second vertical edge, or back edge 38, this edge being supplied with a flange 38' provided by bending the panel plate. Also, as shown in Figure 3, track 40 is supported by a column 41 (which also serves as a stop) at its first end and a column 41' (shown only in Figure 4) at its second end (also shown in Figure 4). The system also comprises a stop 43 placed in approximate coincidence with a first doorway jamb and a stop 44 approximately positioned at a second doorway jamb.

The second trolley 32, is provided at its front and back ends, with angle brackets 33 and 34 to which the permanent magnets 35 and 36 are affixed. The first trolley 22, is provided at its back end with an angle bracket 23 whose flange 24 is aligned with said permanent magnets 35, 36 and located on the same axis 27. This angle bracket 23, including flange 24, is made of a ferromagnetic material, such as steel plate or equivalent.

Figure 4 illustrates the relative positions of elements when the door is closed, as well as some elements not shown in the preceding figure, such as

the second beam-supporting column 41' and stop 44 associated with this column, said stop being substantially aligned with a doorway jamb (not illustrated), the doorway width being defined by the distance between said jamb and jamb 45, partially visible in the figure. In the closed position, front edge 25 of first panel 21 touches stop 44, and back edge 26 of this panel is in a position roughly coincident with front edge 37 of second panel 31. The position of these edges 26 and 37 substantially corresponds to the middle of said access doorway. Back edge 38 of second panel 31 is positioned in substantial coincidence with doorway jamb 45. As shown, stop 43 is in contact with the inner side of flange 38', preventing panel 31 from moving to the center of the doorway. In accordance with the figure, first trolley 22 and second trolley 32 are rigidly bound by the effect of magnetic attraction between permanent magnet 35 and flange 24 so as to move as one unit. Although rigid, the engagement between these trolleys is not permanent, being disconnected by applying a force that exceeds the force of magnetic attraction.

Figure 5-a illustrates the beginning of the door opening when the first subassembly 20, which comprises panel 21, is driven in the direction indicated by arrow 47A. This impulse may be provided by an electromechanical drive to which the subassembly is connected, or if the door is installed on a floor, by the temporary link between subassembly 20 and the corresponding subassembly of the panel (not shown) on the door of the elevator car, when it is stopped at that floor. As shown in Figure 5-a, the driven first subassembly 20 causes the front edge 25 to move away from stop 44. Because trolleys 22 and 32 are engaged by the attraction between permanent magnet 35 and the flange of ferromagnetic material 24, the second subassembly 30, which comprises panel

31, will move together with first subassembly 20 in the same direction and at the same speed, as indicated by arrow 47B. In other words, both the above subassemblies are jointly and rigidly linked and operate as one unit at this stage of the door opening operation.

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Figure 5-b illustrates a following stage of the opening operation, after second subassembly 30 has travelled to the end of its course. As illustrated, column 41 acts as a stop limiting the movement of this subassembly. Arrow 48B in the drawing symbolizes the immobilized condition of subassembly 30. The impulse applied to trolley 22 causes a force to be applied to the engagement between these subassemblies 20, 30 that exceeds the strength of magnetic attraction of the magnetic link between magnet 35 and flange 24 that disrupts the engagement between the second subassembly 30, now immobilized, and the first subassembly 20 that continues to move as indicated by arrow 47A.

15

Figure 5-c illustrates completion of the door opening operation: at the end of the movement of subassembly 20, when the back edge 26 of panel 21 is substantially aligned with the back edge of panel 31, the two panels 21 and 31 substantially overlapping, subassembly 20 is now stopped, as symbolized by arrow 48A. The front edge 25 of panel 21 is substantially aligned with the front edge 37 of panel 31, the position of both these edges coinciding with the jamb of the doorway 50. In this condition, flange 24 associated with trolley 22 comes into contact and is magnetically linked with the permanent magnet 36 aligned with the back edge of panel 31, to form a new, secondary engagement between these subassemblies 20, 30.

25

Because of the formation of this secondary engagement, the two trolleys 22, 32 and respective panels 21, 31 will move together when an impulse to close the door is applied to first subassembly 20. This is illustrated in Figure 5-d, which shows the start of the doorway closing operation, with both subassemblies 20 and 30 jointly moving at the same speed on parallel paths in the direction indicated by arrows 49A, 49B.

Second subassembly 30 continues to be moved together with first subassembly 20 to the point where flange 38' of panel 31 halts at fixed stop 43, this second subassembly 30 then being immobilized, symbolized by arrow 48B, as shown in Figure 5-e. Because trolley 22 continues to be driven in the direction of closing the door, a force, which is greater than that of the force of magnetic attraction between flange 24 of the trolley 22 and the magnet 36 of trolley 32 provides the separation of the flange 24 from the magnet 36. Figure 5-e shows the stage after this separation, in which first subassembly 20 continues in its movement toward stop 44, as indicated by arrow 49A. The closing operation ends when front edge 25 of panel 21 bears against stop 44, returning the door to the initial condition shown in Figure 4.

Figures 6 and 7 show a schematic graphically representing operation of the system being proposed. Figure 6, which corresponds to the perspective view of Figure 4, shows subassemblies 20 and 30 and the elements involved in operation of the system, highlighting the following:

- (a) front edge 25 of panel 21 of the first subassembly 20 in contact with stop 44 when the door is closed;

(b) flange 24 of ferromagnetic material, substantially aligned with back edge 26 of panel 21 of the first subassembly 20;

5 (c) first permanent magnet 35 mounted on angle bracket 33, substantially aligned with front edge 37 of panel 31 of second subassembly 30;

(d) second permanent magnet 36 affixed to angle bracket 34, aligned with the back edge 38 of panel 31 of second subassembly 30;

10 (e) fixed stop 43 that limits the movement of subassembly 30 in contact with the flange 38' formed by the upper part of the back edge 38 of panel 31; and

(f) column 41 that supports track 40 (not represented in this figure)  
15 on which trolleys 22 and 32 move, this column serving as a stop during door opening operation.

As indicated, flange 24 and magnet 35 are in physical contact in the closed position, forming a magnetic coupling  $v_m$  that acts as a rigid engagement  
20 between subassemblies 20 and 30.

Figure 7-a illustrates the start of the door opening operation by applying an impulse to first subassembly 20, as arrow 47A suggests. Because of the presence of magnetic coupling  $v_m$ , this impulse is transferred to second  
25 subassembly 30, which moves jointly with first subassembly 20, at the same speed and in the same direction, indicated by arrow 47B.

Figure 7-b shows the situation after the movement of second subassembly 30 has been halted by contact between back edge 38 of this subassembly and the end-of-course stop consisting of column 41. Although the second subassembly 30 is stopped, the force applied to the first subassembly 20 is sufficient to overcome the magnetic attraction force between flange 24 of the first subassembly 20 and magnet 35 of the second subassembly 30, breaking the mentioned magnetic coupling  $v_m$  so that first subassembly 20 may now move independently at speed 47A.

The end of the movement of the first subassembly 20 occurs at the end of the approach of this subassembly to the end-of-course stop consisting of column 41, when flange 24 aligned with back edge 26 (not referenced in the figure) bears against second magnet 36. In this situation, shown in Figure 7-c, both subassemblies 20, 30 are stopped, with the access doorway 50 of the door fully open. Also, because of contact between flange 24 and magnet 36, a second magnetic coupling  $v'_m$  is formed, creating a rigid link between the two subassemblies 20, 30 that are mutually engaged.

The door's closing is initiated when an impulse is applied to first subassembly 20 in the opposite direction to that producing the door's opening. As illustrated in Figure 7-d, this subassembly 20 will move toward stop 44, indicated by arrow 49A. Because of the engagement between both subassemblies provided by rigid magnetic coupling  $v'_m$ , subassembly 30 moves in cooperation in the same direction and at the same speed 49B.

This movement will be blocked when flange 38' of second

subassembly 30 comes up against fixed stop 43, a situation shown in Figure 7-e. First subassembly 20 continues to be driven by the door closing means, generating a force greater than the limit of the attraction force of the magnetic coupling  $v'_m$  between flange 24 and magnet 36, and resulting in the decoupling of these elements, as shown in the figure. As a consequence of this decoupling, subassembly 20 is freed to move in the direction indicated by arrow 49A, toward stop 44 at the end of the doorway, where the system will be returned to the initial condition illustrated in Figure 6.

From observation of sequences 5-a to 5-e and 7-a to 7-e it can be seen that the course travelled by subassembly 20 roughly corresponds to the width of doorway 50, while subassembly 30 travels only the distance between stop 43 and the end-of-course stop 41. Therefore, the path travelled by second subassembly 30 is shorter than the path travelled by first subassembly 20. Generally speaking, the path traveled by the second subassembly 30 is approximately equal to the difference between the width of the doorway 50 and the width of the first subassembly 20. In the specific embodiments shown in the aforementioned figures, where the width of each subassembly 20, 30 equals approximately half the doorway width 50, the path travelled by the second subassembly 30 is approximately half the path travelled by first subassembly 20.

In an alternative embodiment of the invention shown in Figure 8, second permanent magnet 36 is not installed on trolley 32. In this embodiment, detailed in Figure 10, fixed magnet 36' is attached to angle bracket 51, which is in turn installed on track 40, in a position substantially aligned with column 41, which serves as the stop delimiting the end of the route traveled by trolleys 22

and 32. As illustrated, magnet 36' is also aligned with axis 53 which passes through flange 52 of angle bracket 34, this piece being made of ferromagnetic material. In the initial position of the assembly (see Figure 8), with the door fully closed, the situation is similar to that shown in Figure 6 with the magnetic coupling  $v_m$ , forming a rigid engagement between the first and second subassemblies 20, 30. Consequently, when an impulse is applied to the first subassembly 20 in the direction of the door opening, as shown by arrow 47A, second subassembly 30 will move together with it, as shown by arrow 47B in Figure 9-a, similarly to the preceding embodiment illustrated in Figure 7-a.

Figure 9-b illustrates a situation in which the second subassembly 30 has reached the end of its course, where flange 52 makes contact with magnet 36' aligned with column 41, which serves as the stop. The contact between flange 52 and magnet 36' creates a magnetic coupling  $v''_m$ . Similarly to the previous situation illustrated in Figure 7-b, the attraction force of magnetic coupling  $v_m$  is overcome and first subassembly 20 continues its movement toward upright 41, as indicated by arrow 47A. Movement of the first subassembly 20 stops when flange 24 (substantially aligned with back edge 26 of first subassembly 20) bears against flange 52 of second subassembly 30, which is already stopped. Figure 9-c shows this condition, which corresponds to complete opening of access doorway 50 of the elevator. Observe that, in addition to the magnetic coupling  $v''_m$  between this flange 52 and magnet 36', there is an additional magnetic link (not shown) between flange 24 and the magnet 36', but weaker than magnetic coupling  $v''_m$ .

The closing operation begins with application of an impulse to first

subassembly 20, which moves in the direction indicated by arrow 49A in Figure 9-d. Contrary to what occurs in the first embodiment of the invention (see Figure 7-d), subassembly 30 remains coupled to magnet 36' via magnetic coupling  $v''_m$ , which is stronger than the bond between the magnet 36' and flange 24, which disengages with relative ease when first subassembly 20 is driven. Movement of second subassembly 30 begins only when flange 24 contacts magnet 35, with the consequent restoration of magnetic coupling  $v_m$ , as shown in Figure 9-e. From that moment on, subassembly 30 will be moved together with subassembly 20 at the same speed 49B, in the direction of closing the doorway, this closure being accomplished when front edge 25 of the first subassembly 20 comes into contact with stop 44 and the flange 38' of the second subassembly 30 comes into contact with fixed stop 43, as shown in Figure 9-f.

The sequence of drawings of Figure 11 illustrates yet another embodiment of the invention, in which the flange of ferromagnetic material 24' interacts with permanent magnet 36 positioned substantially in alignment with the back edge 38 of second subassembly 30. As with previous embodiments, the operations of opening and closing the door are carried out in two phases, one phase of movement together in which both subassemblies 20, 30 are rigidly coupled and move together at the same speed, and a phase of independent movement, in which second subassembly 30 is uncoupled from first subassembly 20, and only first subassembly 20 moves while the second subassembly remains immobile. In the embodiments shown in Figures 7-a to 7-e and Figures 9-a to 9-f, the opening operation consists of the first phase of movement together and afterward the phase of independent movement. The closing operation of the embodiment in Figures 7-a to 7e consists of an initial

phase of movement together, as shown in Figure 7-d, followed by a phase of independent movement as subassembly 20 moves and subassembly 30 is immobile. In the closing operation of the embodiment of Figures 9-a to 9-f, an initial phase of independent movement precedes a phase of moving together.

5 Unlike those that precede it, in the embodiment of Figures 11-a to 11-f, door opening includes an initial phase of independent movement, in that only subassembly 20 moves, followed by a phase of movement together, shown in Figure 11-c, in which both subassemblies move together to complete opening of the doorway 50. The closing operation is similar to that of the embodiment  
10 shown in Figures 7-a to 7-e, that is, a first phase of movement together followed by a second phase of independent movement.

The differences in the relative movement of the embodiments shown in Figures 7-a to 7-e, Figures 9-a to 9-f, and Figures 11-a to 11-f may be  
15 summarized as follows. During a complete cycle of door opening followed by door closing, the panels 21, 31 move:

(a) together, then separate, then together, and then separate (i.e., T-S-T-S) in the embodiment of Figures 7-a to 7-e;

20 (b) together, then separate, then separate, and then together (i.e., T-S-S-T) in the embodiment of Figures 9-a to 9-f; and

(c) separate, then together, then together, and then separate (i.e., S-T-T-S) in the embodiment of Figures 11-a to 11-f.

25

The illustrative embodiments do not exhaust the possible variants of

the invention, which can be modified by persons skilled in the art while remaining within the boundaries of the inventive idea. Thus, for example, an embodiment based on the foregoing could be readily envisioned in which during a complete cycle of door opening followed by door closing the panels 21, 31  
5 would move separate, then together, then separate, and then together (i.e., S-T-S-T). This could be achieved by using magnets 36 and 36' without magnet 35 and in which the attraction force of magnetic coupling  $v'_m$  would be less than the attraction force of magnetic coupling  $v''_m$ .

10 Moreover, the precise location of the magnets 35, 36, 36' could be altered. For example, rather than being aligned with flange 52, magnet 36' may be affixed directly to stop 41, at a position aligned with the upper portion of flange 38'. If this flange 38' is made of ferromagnetic material, such as steel plate, a magnetic coupling  $v''_m$  will be created between the flange 38' and  
15 magnet 36' when subassembly 30 reaches the end of its course and bears against stop 41 in a manner similar to the embodiment shown in Figures 9-a to 9-f.

The mechanically applied force that enables the decoupling of the magnetic engagement may be adjusted (i.e., reduced) by the addition to the  
20 system of elements that generate a magnetic field, activated when it is desired to trigger separation between the two parts of the engagement. Figure 12 is a principle diagram that illustrates in simplified and schematic form the use of a magnetic field generator (i.e., electromagnet) 55, symbolized by a coil, placed in the position where decoupling needs to occur between subassemblies 20 and 30  
25 during the door opening operation. The magnetic field generator 55 is arranged so that when energized, it generates its field opposite the field of the permanent

magnet 35. Thus, reaching the position illustrated in the figure, a control circuit feeds the generator a pulse of current, resulting in weakening or even canceling the magnetic bond between the flange 24 and the permanent magnet 35 that formed the engagement between the subassemblies 20, 30. Thus, the mutual  
5 disengagement of the subassemblies 20, 30 will require a smaller impulsive force applied to subassembly 20, reducing the mechanical strain on the system.

The use of permanent magnets 35, 36, 36' in conjunction with flanges 24 of ferromagnetic material to provide the engagements is not the only  
10 way to embody the invention. These engagements may be provided in an alternative form of the inventive concept using mechanical coupling means.

Figures 13-a to 13-d show, in schematic and simplified form, one of the possible ways of embodying this type of device that consists of two  
15 mechanical engagement parts 60 and 70 affixed, respectively, to trolleys 22 and 32. The first part 60 consists of a flange 61 and a retention element provided in this case by a cylindrical retention pin 62. The second part 70 consists of a base plate 71, to which a support shaft 72 is attached by way of a movable lock 73. The movable lock 73 has, in its front portion 74 facing the first part 60, a recess  
20 75 that fits the contour of retention pin 62. The lock 73 itself is pressed down by spring 77, and this pressure is adjustable by tightening nut 78. The engagement operation is illustrated in the sequence of Figures 13-a to 13-c. Figure 13-a shows the engagement uncoupled, with lock 73 in the resting position and trolley 22 approaching, as indicated by arrow 63A. Figure 13-b illustrates a  
25 subsequent operational stage, in which the contact of pin 62 against the bottom edge configured as a chamfer 76 of front portion 74 presses lock 73, which

rotates in the direction indicated by the arrow 63B, raising front portion 74. Figure 13-c shows trolleys 22 and 32 fully engaged, lock 73 having returned to its original position indicated by the arrow 63C, thereby providing latching by recess 75 of retention pin 62. The lateral force 64 needed to provide the  
5 decoupling of the engagement is a function of pressure exerted by spring 77 and the angle  $\alpha$  at the point of contact between the retention pin 62 and the recess 75, as illustrated in detail in Figure 13-d.

Figure 14 illustrates application of the same mechanical  
10 engagement principle as illustrated in Figure 13 along with a magnetic field generator (i.e., electromagnet). In this case, the field generated by the coil of the magnetic field generator 56 attracts the free end 74 of lock 73, momentarily overcoming the pressure exerted by spring 77, facilitating locking as well as unlocking of pin 62. Electrical activation of the field generator can be made  
15 based on determination of the positioning of subassemblies 20 or 30 using a known process, such as, for example, photodetector means, magnetic position detector, rotation counter with electromechanical drive that directly or indirectly controls the movement of subassembly 20, and other means that are not the subject of this invention.

20

Triggering of the lock 73 in the engagement mechanism may also be effected by using a permanent magnet 58, as illustrated in the sequence of drawings in Figures 15 and 16. The sequence of operating the engagement is illustrated in Figures 16-a to 16-d and the disengagement is illustrated in Figures  
25 16-e to 16-g. With respect to the sequence of engagement shown in Figures 16-a to 16-d, first engagement part 60 of the coupling, affixed to trolley 22, is

approaching (in the direction of arrows 47A in Figure 15-a and 63A in Figure 16-a) second engagement part 70, affixed to trolley 32, which remains immobile. As illustrated, front portion 74 of lock 73 is positioned within the magnetic field of permanent magnet 58, which is sufficiently intense to overcome the force of spring 77, making front portion 74 move upward. This phase of the operating sequence is also shown in simplified form in Figure 15-a, from which the spring 77 has been omitted for a clearer view. The movement of front portion 74 is sufficient to allow pin 62 to be easily received, without touching it, under the chamfered underside 76 of lock 73, as shown in Figure 16-b. In this manner, pin 62 freely approaches, recess 75. In the situation illustrated in Figures 16-c and 15-c, pin 62 has entered the recess, and is pressing edge 79 in such a way as to push trolley 32, as indicated by arrow 63'. Because of this movement, front portion 74 of lock 73 recedes from the magnetic field of permanent magnet 58. As a result, the lowering of this end occurs, as represented by arrow 63C. Figure 16-d and Figure 15-c show the complete engagement operation, with pin 62 firmly seated in recess 75 under the action of spring 77, and the two trolleys 22 and 32 moving together at the same speed 63A, 63B (in Figure 16-d) and 47A, 47B (in Figure 15-c).

Figures 16-e to 16-g illustrate the disengagement sequence that begins with the two rigidly coupled trolleys 22, 32 moving together toward fixed permanent magnet 58, at speed 67A, 67B. In the situation illustrated in Figure 16-f, the front portion 74 of lock 73 is attracted by the magnetic field of permanent magnet 58. This attraction raises the end in the direction of arrow 63B, thereby releasing pin 62 from recess 75 and allowing disconnection between the two parts 60, 70 of the engagement, so that trolley 22 can move in

the direction indicated by arrow 67A, without dragging trolley 32. Thus, trolley 32 remains stationary in the position illustrated in Figure 16-g, while trolley 22 freely moves away.

5           The embodiment illustrated in Figures 15 and 16 has the advantage of dispensing with any electrical activation of the magnetic field generator, while ensuring operation with minimum wear of the mechanical parts in contact, because the disconnection force, as indicated by arrow 64 and the connection force indicated by arrow 65 in Figure 12-d, are substantially reduced, or even  
10   zero.

          The aforementioned discussion is intended to be merely illustrative of the present invention and should not be construed as limiting the appended claims to any particular embodiment or group of embodiments. Thus, while the  
15   present invention has been described in particular detail with reference to specific exemplary embodiments thereof, it should also be appreciated that numerous modifications and changes may be made thereto without departing from the broader and intended scope of the invention as set forth in the claims that follow.

20

          The specification and drawings are accordingly to be regarded in an illustrative manner and are not intended to limit the scope of the appended claims. In light of the foregoing disclosure of the present invention, one versed in the art would appreciate that there may be other embodiments and  
25   modifications within the scope of the present invention. Accordingly, all modifications attainable by one versed in the art from the present disclosure

within the scope of the present invention are to be included as further embodiments of the present invention. The scope of the present invention is to be defined as set forth in the following claims.

### Claims

1. Drive system of an elevator door comprising:

at least two subassemblies (20, 30) that move sideways and in the same direction to open and close a doorway (50), the subassemblies (20, 30) comprising:

a first subassembly (20) comprising a first panel (21) affixed to a first trolley (22) and configured to move between a first stop (44) and a second stop (41) along a track (40) that extends across the doorway (50);

a second subassembly (30) comprising a second panel (31) affixed to a second trolley (32) and configured to move along the track (40),

wherein, in both the opening and closing operation of the door: (a) a path traveled by the first subassembly (20) in its movement is approximately equal to the width of the doorway (50); and (b) a path of the second subassembly (30) is shorter than the path of the first subassembly (20);

a releasable engagement device between the subassemblies (20, 30) comprising:

first engagement member (24, 60) affixed to the first trolley (22); and

second engagement member (35, 36, 70) affixed to the second trolley (32),

wherein the first and second engagement members are configured to be coupled by a force of mutual attraction and/or mechanical interaction of such first and second engagement members when the trolleys (22, 32) are impelled against each other, and

wherein the first and second engagement members are

configured to be decoupled by application of a force that is configured to overcome the force of mutual attraction and/or mechanical interaction.

2. Drive system of an elevator door in accordance with Claim 1,  
5 characterized by the fact that the releasable engagement device is provided by magnetic attraction between the first engagement member (24) and the second engagement member (35, 36).

3. Drive system of an elevator door in accordance with Claim 1,  
10 characterized by the fact that the releasable engagement device is provided by mechanical coupling between the first engagement member (60) and the second engagement member (70).

4. Drive system of an elevator door in accordance with Claim 1,  
15 characterized by the fact that the first engagement member (24, 60) is substantially aligned with a back edge (26) of the first panel (21).

5. Drive system of an elevator door in accordance with Claim 1,  
characterized by the fact that the first engagement member (24, 60) is  
20 substantially aligned with a front edge (37) of the second panel (31) when the subassemblies (20, 30) are engaged.

6. Drive system of an elevator door in accordance with Claim 1,  
characterized by the fact that the second engagement member (35, 70) is  
25 substantially aligned with a front edge (37) of the second panel (31).

7. Drive system of an elevator door in accordance with Claim 1, characterized by the fact that the second engagement member (36) is substantially aligned with a back edge (38) of the second panel (31).

5           8. Drive system of an elevator door in accordance with Claim 2, characterized by the fact that the first engagement member comprises one of a piece of ferromagnetic material (24) and permanent magnets.

10           9. Drive system of an elevator door in accordance with Claim 8, characterized by the fact that the second engagement member comprises the other of the piece of ferromagnetic material (24) and permanent magnets (35, 36).

15           10. Drive system of an elevator door in accordance with Claim 3, characterized by the fact that the first engagement member comprises a retained element (62) associated with the first trolley (22) and the second engagement member comprises a retainer element (73) associated with the second trolley (32).

20           11. Drive system of an elevator door in accordance with Claim 10, characterized by the fact that the retained element consists essentially of a pin (62) and the retainer element consists essentially of a movable lock (73) with a recess (75) that fits the contour of the pin (62).

25           12. Drive system of an elevator door in accordance with Claim 2, further comprising a magnetic field generator (55, 56, 58) situated at a fixed

location and near an engagement position of the engagement device.

13. Drive system of an elevator door in accordance with Claim 12, characterized by the fact that the magnetic field generator consists essentially of  
5 an electromagnet (55, 56).

14. Drive system of an elevator door in accordance with Claim 12, characterized by the fact that the magnetic field generator consists essentially of a permanent magnet (58).  
10

15. Drive system of an elevator door in accordance with Claim 1, characterized by the fact that the widths of the first (21) and second panels (31) are approximately equal and substantially equal to half the width of the doorway (50), the length of the path traveled by the second subassembly (30) in its  
15 movement during the door opening and closing operations being approximately half the length of the path traveled by the first subassembly (20) during the door opening and closing operations.

16. Method of driving an elevator door comprising two  
20 subassemblies (20, 30) that move sideways and in the same direction for opening and closing a doorway (50), the first subassembly (20) comprising a first panel (21) affixed to a first trolley (22) and the second subassembly (30), driven by the first subassembly, comprising a second panel (31) affixed to a second trolley (32), the trolleys (22, 32) moving along a track (40) that extends  
25 across the doorway (50) between a first (44) and a second stop (41), a path traveled by the first subassembly (20) in its movement being approximately

equal to the width of the doorway (50) and a path of the second subassembly (30) being approximately equal to the difference between the width of the doorway (50) and the width of the first subassembly (20) in the operation of opening as well as the operation of closing the door, said method comprising the steps of:

coupling the first and second subassemblies (20, 30) by way of a releasable engagement device that includes a first engagement member (24, 60) affixed to the first trolley (22) and second engagement member (35, 36, 70) affixed to the second trolley (32);

moving the coupled first and second subassemblies (20, 30) together at the same speed;

uncoupling the first subassembly (20) from the second subassembly (30); and

moving the uncoupled first subassembly (20) while the second subassembly (30) remains immobile.

17. Method of driving an elevator door in accordance with Claim 16, characterized by the fact that the step of coupling the two subassemblies (20, 30) is provided by a mechanical coupling between the first and second engagement members when the trolleys (22, 32) move against each other.

18. Method of driving an elevator door in accordance with Claim 16, characterized by the fact that the step of coupling the two subassemblies (20, 30) is provided by a magnetic attraction force between the first engagement member (24) affixed to the first trolley (22) in contact with the second engagement member in the form of a permanent magnet (35, 36) affixed to the

second trolley (32).

19. Method of driving an elevator door in accordance with Claim 18, characterized by the fact that the step of decoupling the first and second engagement members is provided by applying a decoupling force to the first trolley (22) that is greater than the magnetic attraction force.

20. Method of driving an elevator door in accordance with Claim 19, further comprising the step of:  
10 triggering an electromagnet (55) to generate a magnetic field that weakens the magnetic field provided by the permanent magnet (35, 36) affixed to the second trolley (32), wherein the application of the decoupling force is substantially simultaneous with the triggering of the electromagnet (55).

15 21. Method of driving an elevator door in accordance with Claim 16, characterized by the fact that the path for the second subassembly (30) in its movement during door opening and closing operations is approximately half the width of the doorway (50).

20 22. Method of driving an elevator door in accordance with Claim 16, characterized by the fact that the step of moving together comes before the step of independent movement of the first subassembly (20) in the door opening operation.

25 23. Method of driving an elevator door in accordance with Claim 16, characterized by the fact that the step of moving together comes before the

step of independent movement of the first subassembly (20) in the door closing operation.

24. Method of driving an elevator door in accordance with Claim  
5 16, characterized by the fact that the step of independent movement of the first subassembly (20) precedes the step of moving together during the door opening operation.

25. Method of driving an elevator door in accordance with Claim  
10 16, characterized by the fact that the step of independent movement of the first subassembly (20) precedes the step of moving together during the door closing operation.

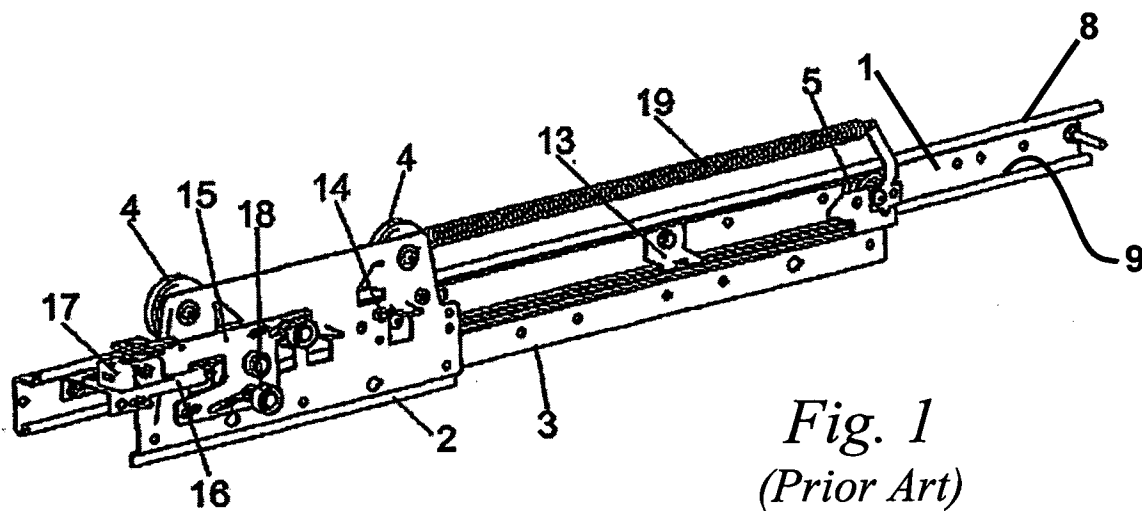


*Fig. 1*  
(Prior Art)

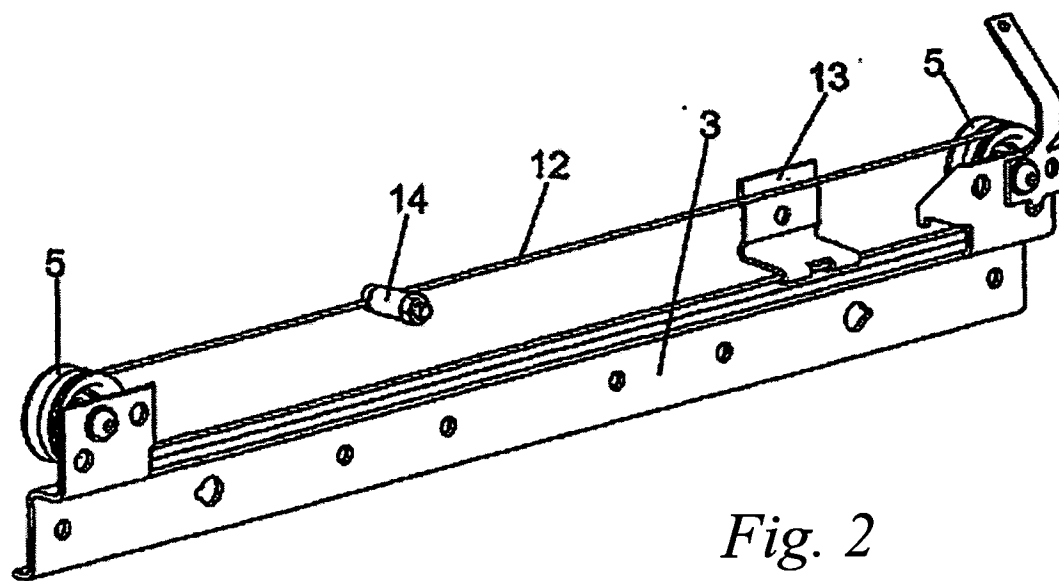


*Fig. 2*  
(Prior Art)

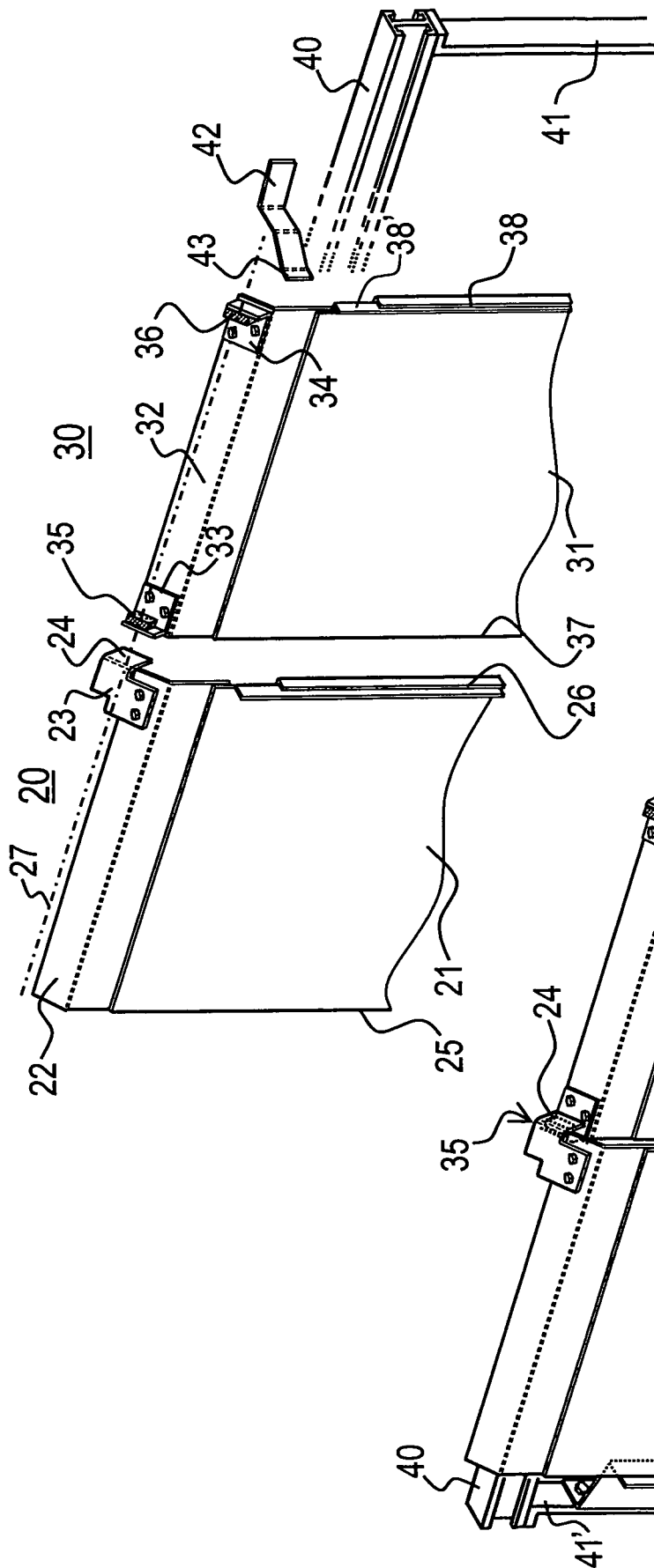


Fig. 3

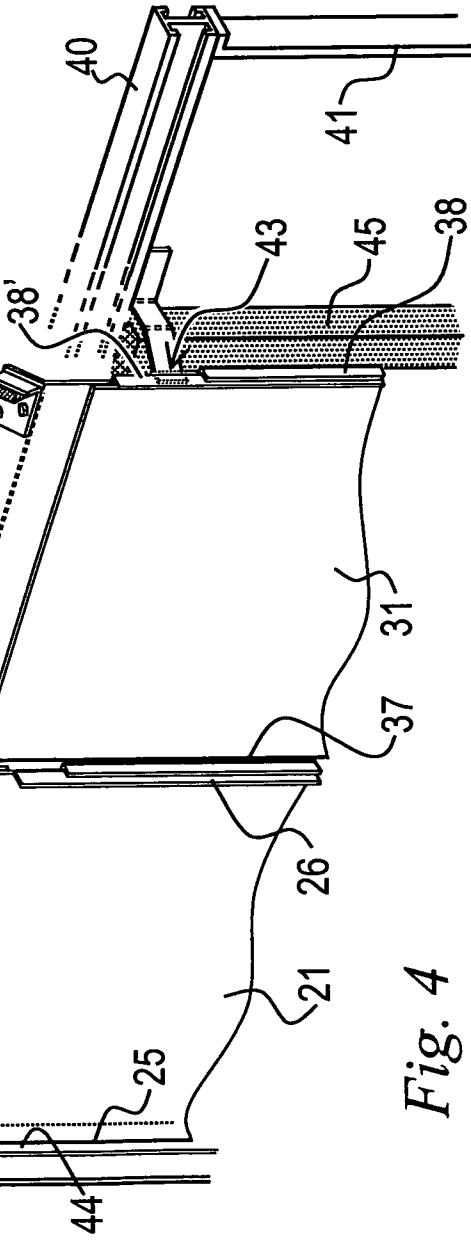


Fig. 4

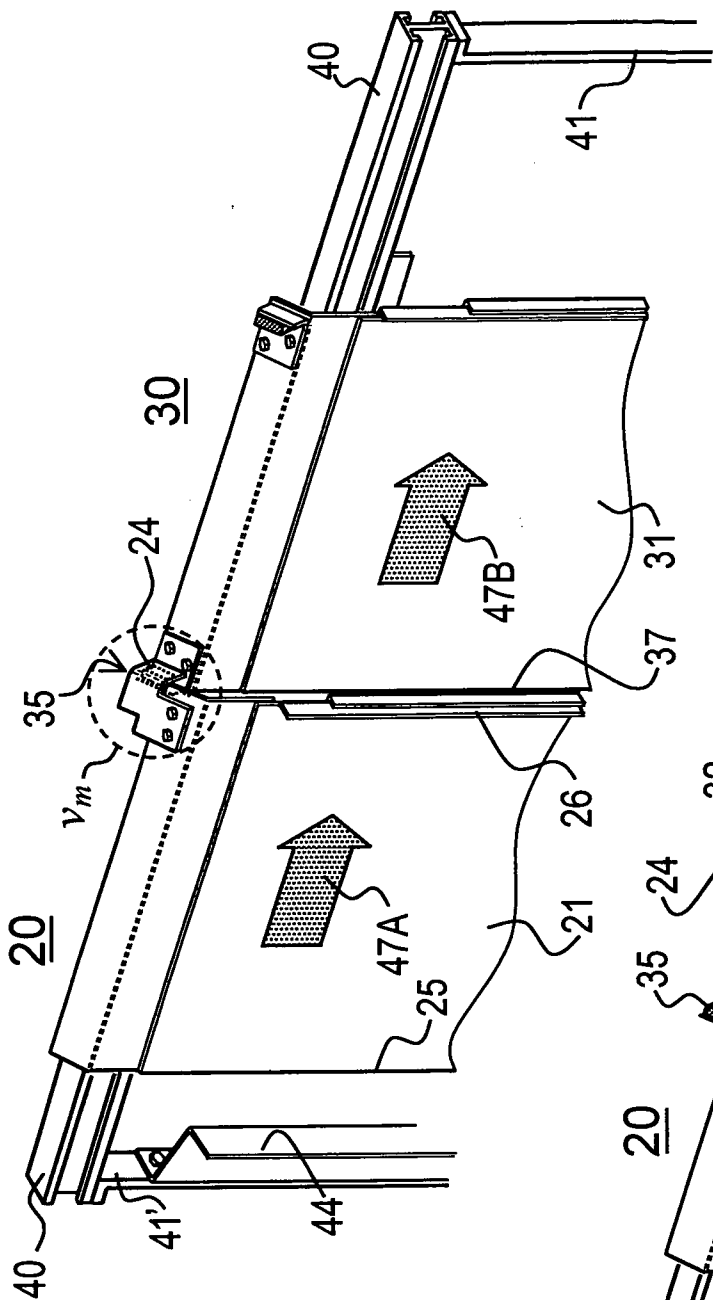


Fig. 5-a

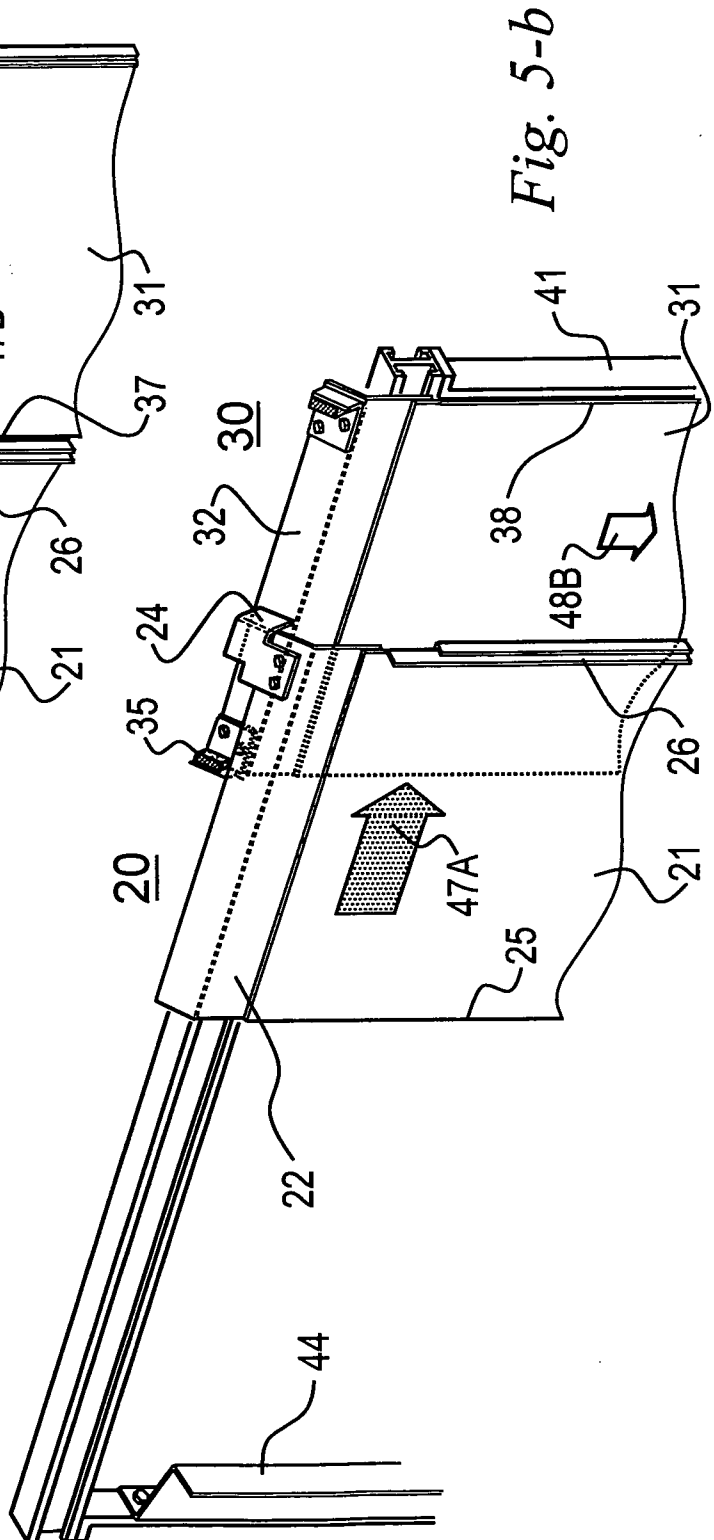


Fig. 5-b

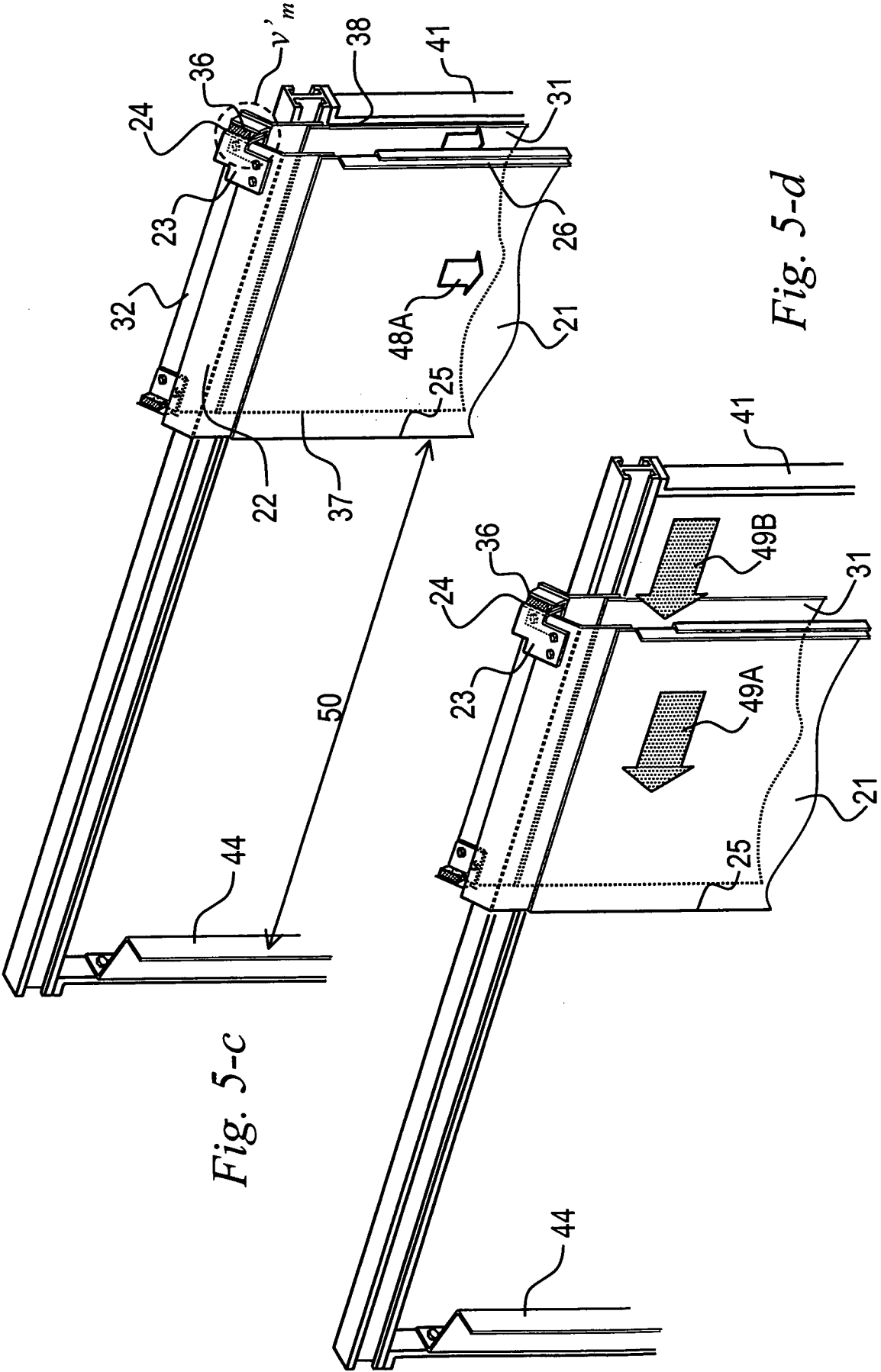
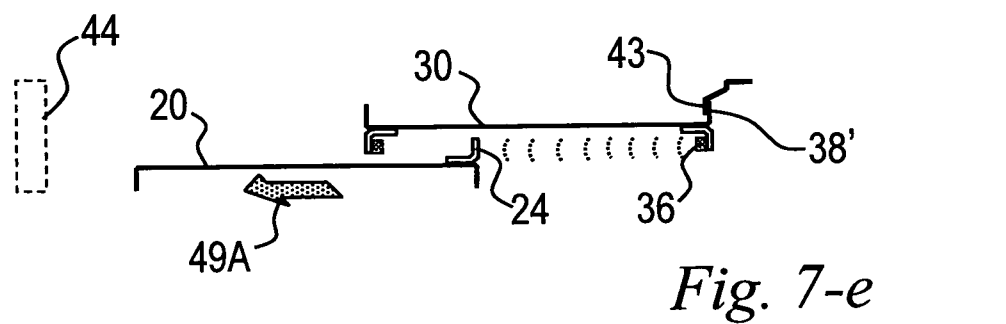
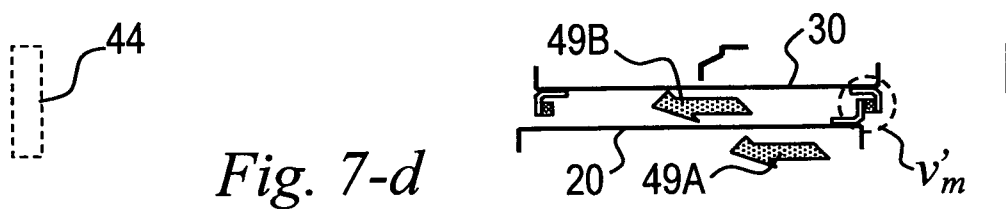
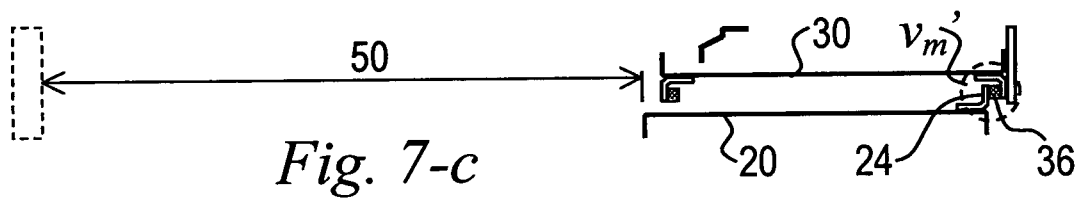
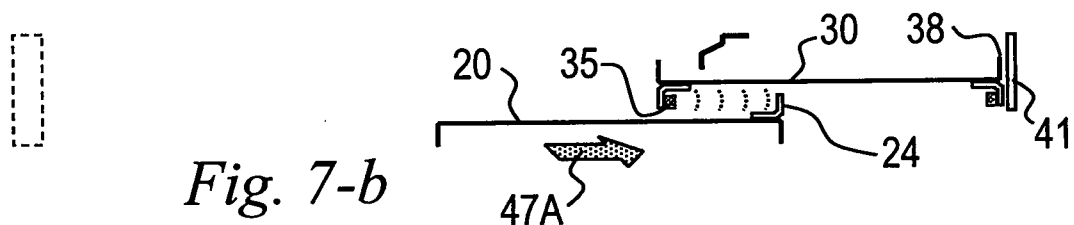
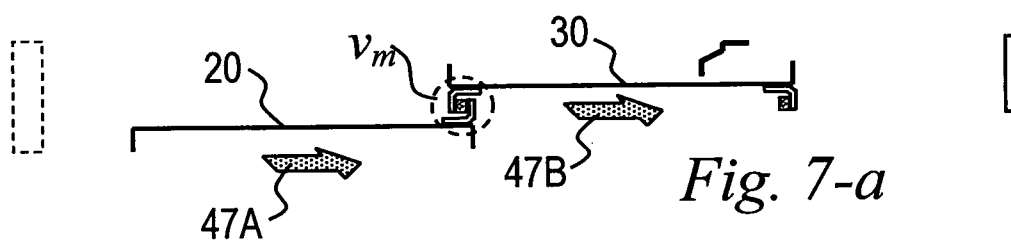
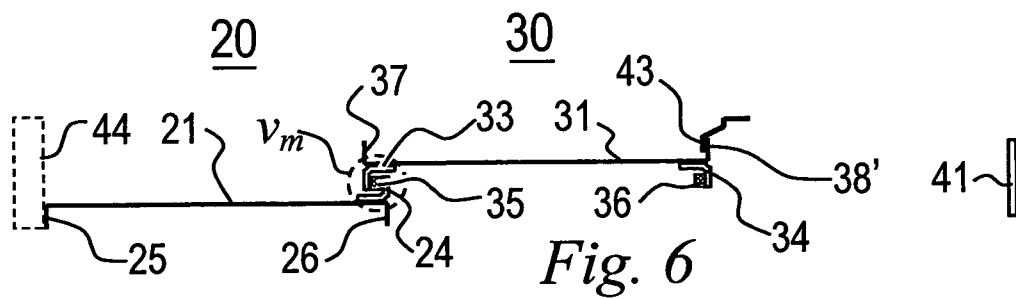
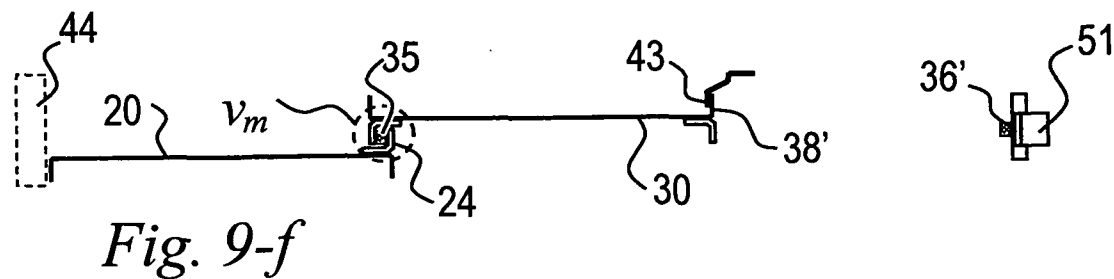
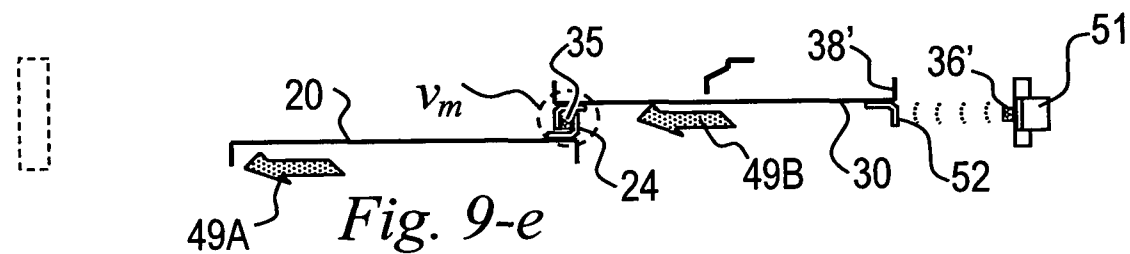
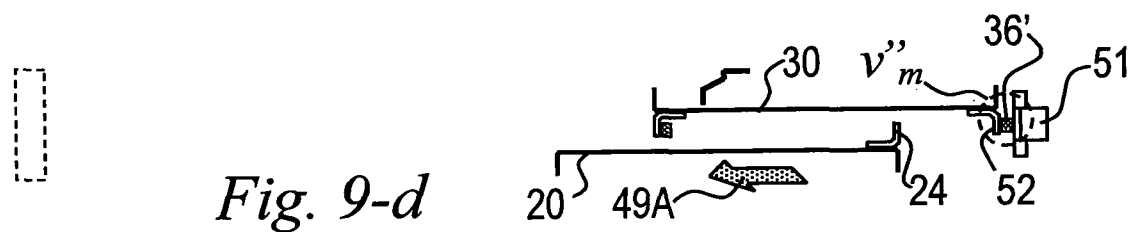
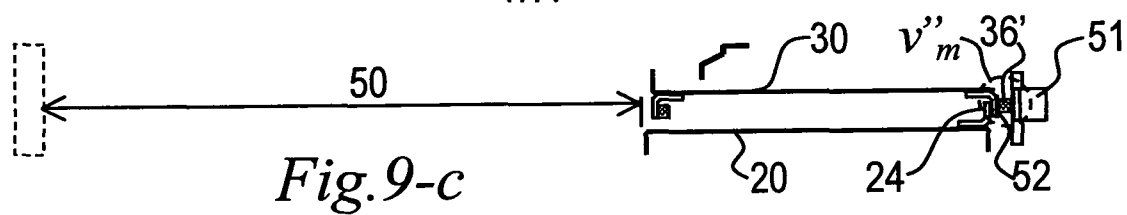
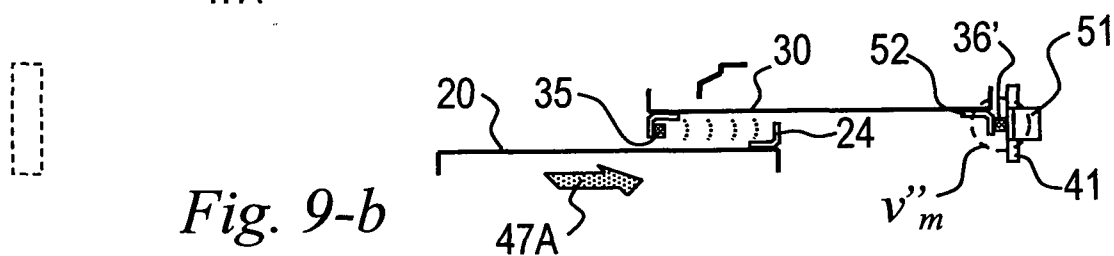
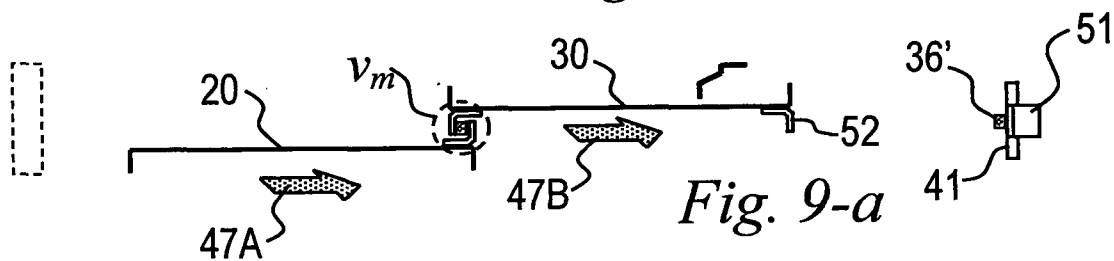
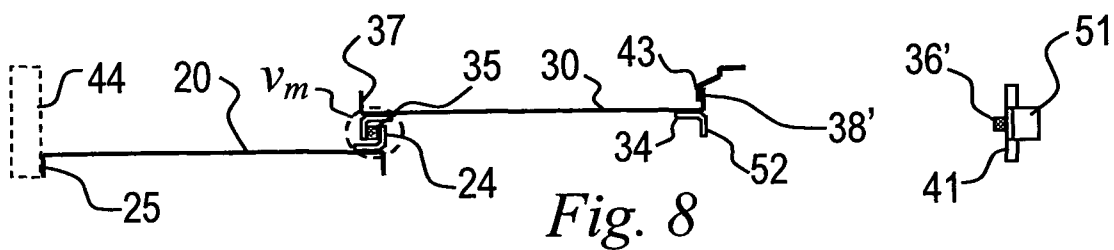
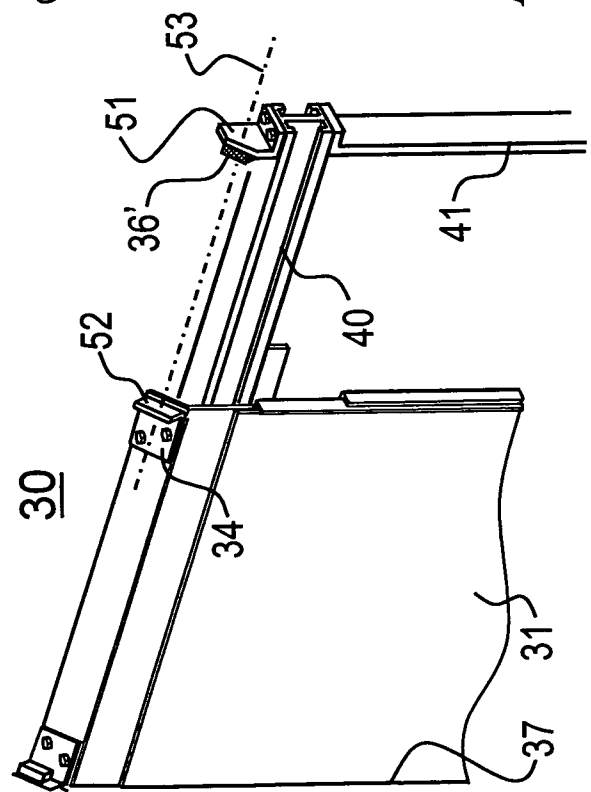
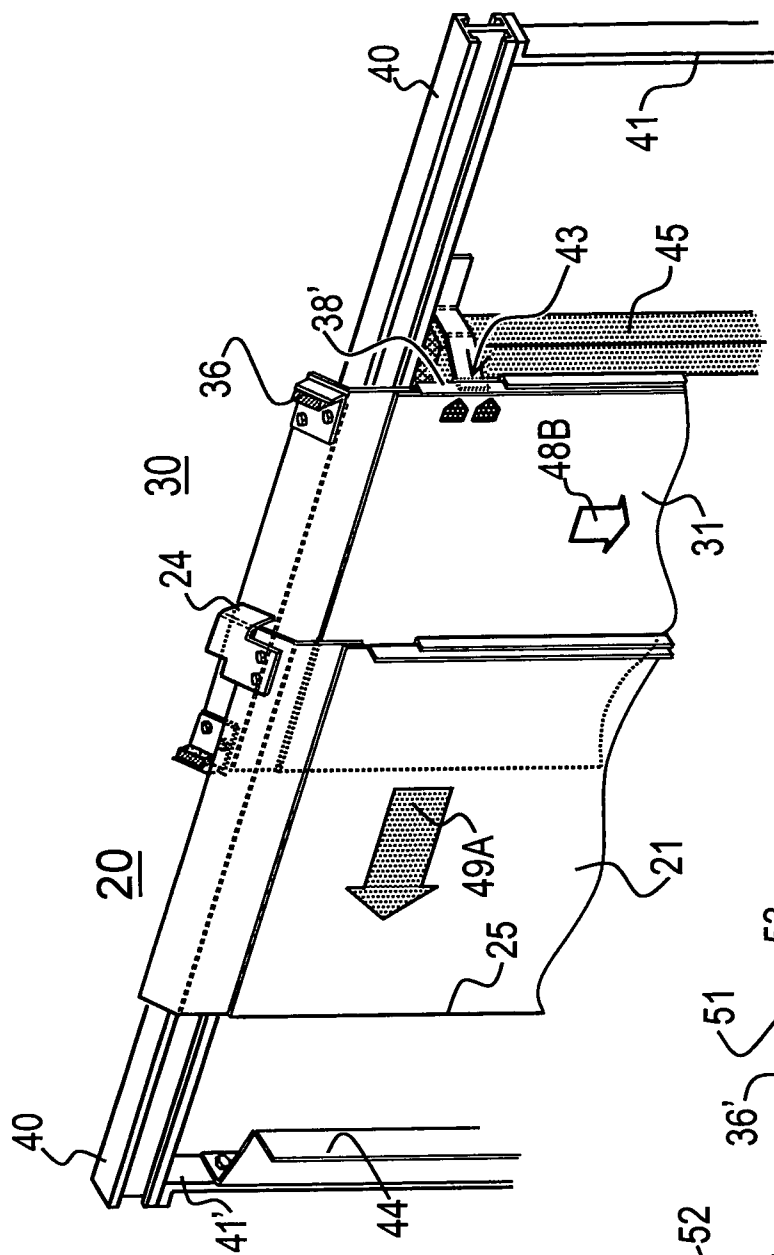


Fig. 5-c

Fig. 5-d







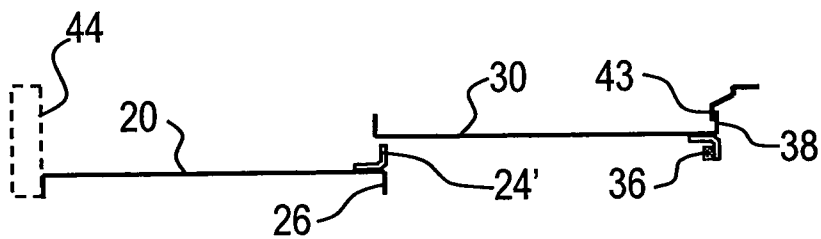


*Fig. 11-a*

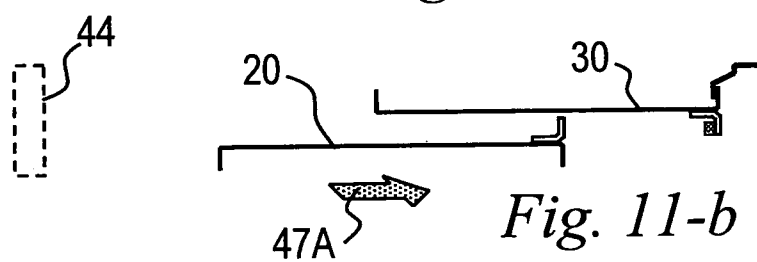


*Fig. 11-b*

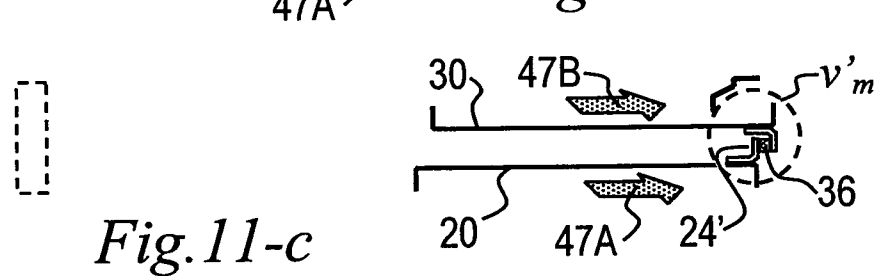


*Fig. 11-c*

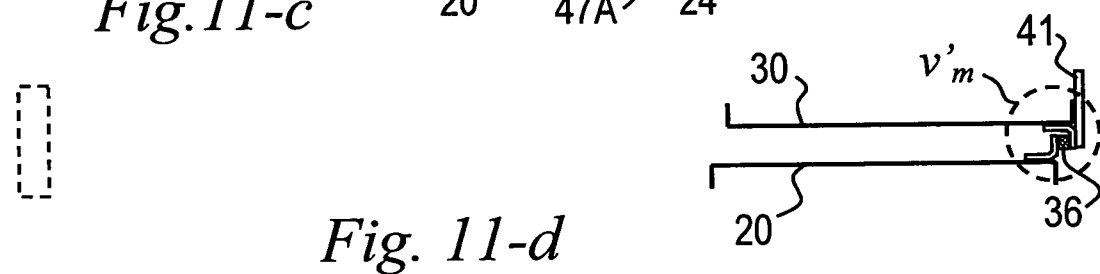


*Fig. 11-d*



*Fig. 11-e*

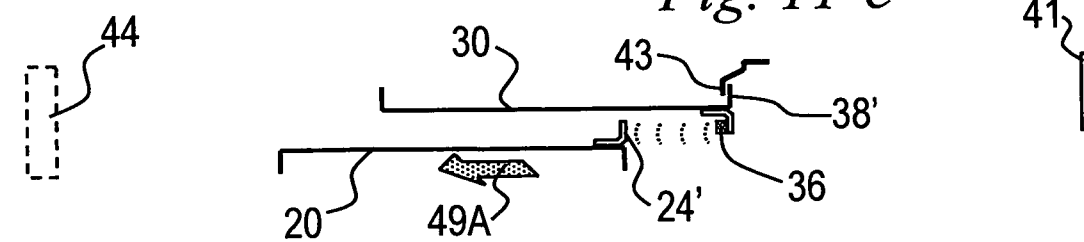


*Fig. 11-f*

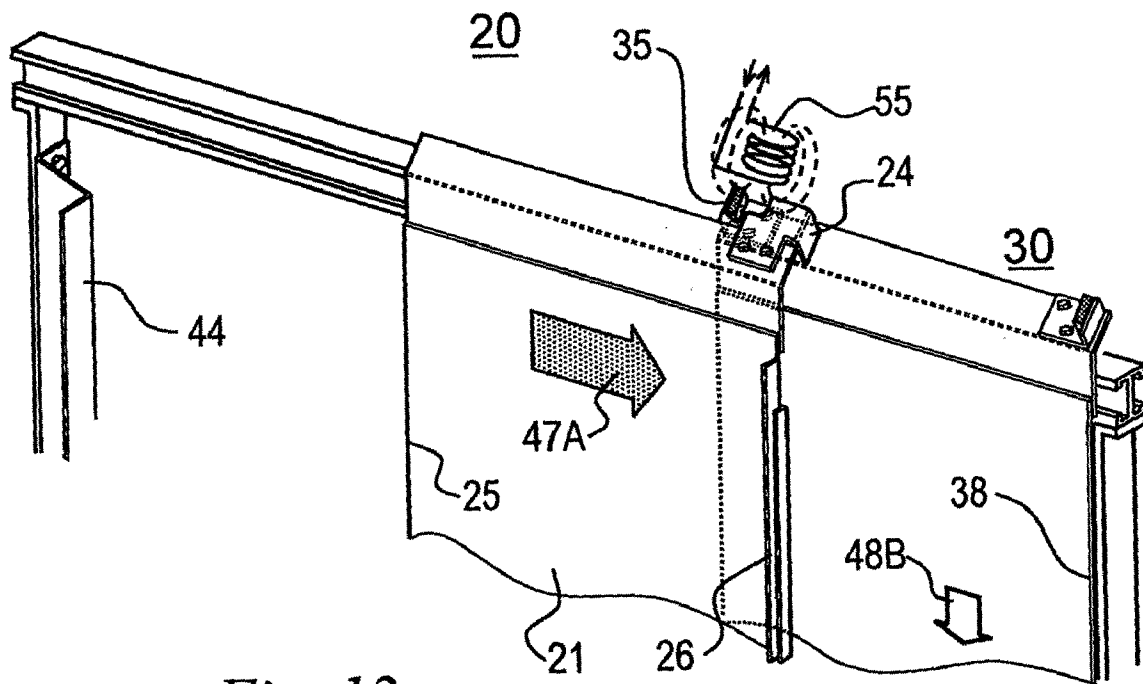


*Fig. 12*

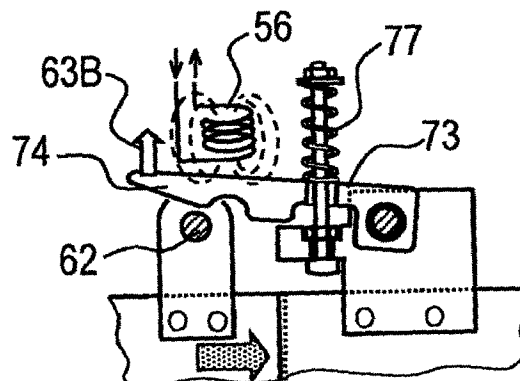
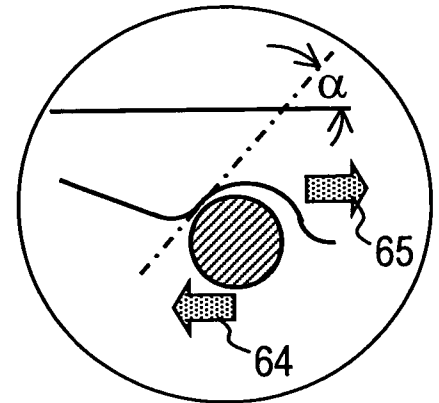
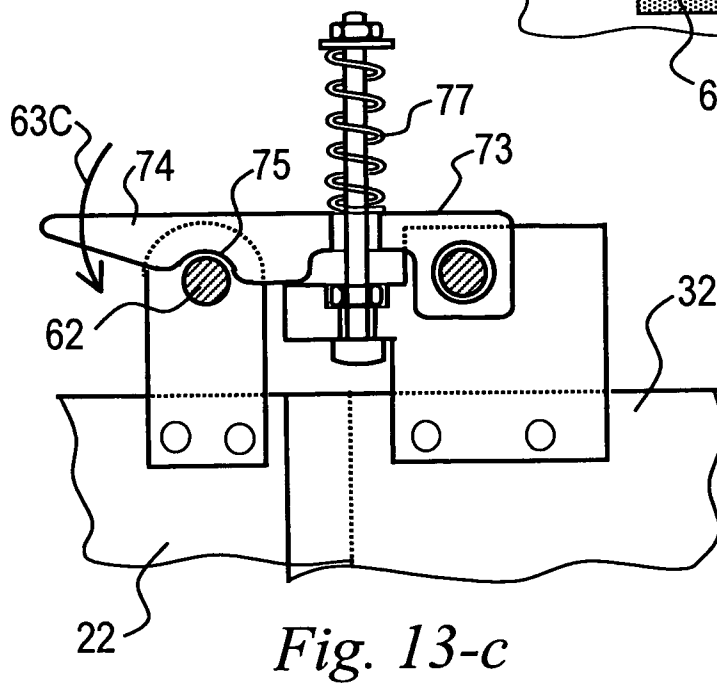
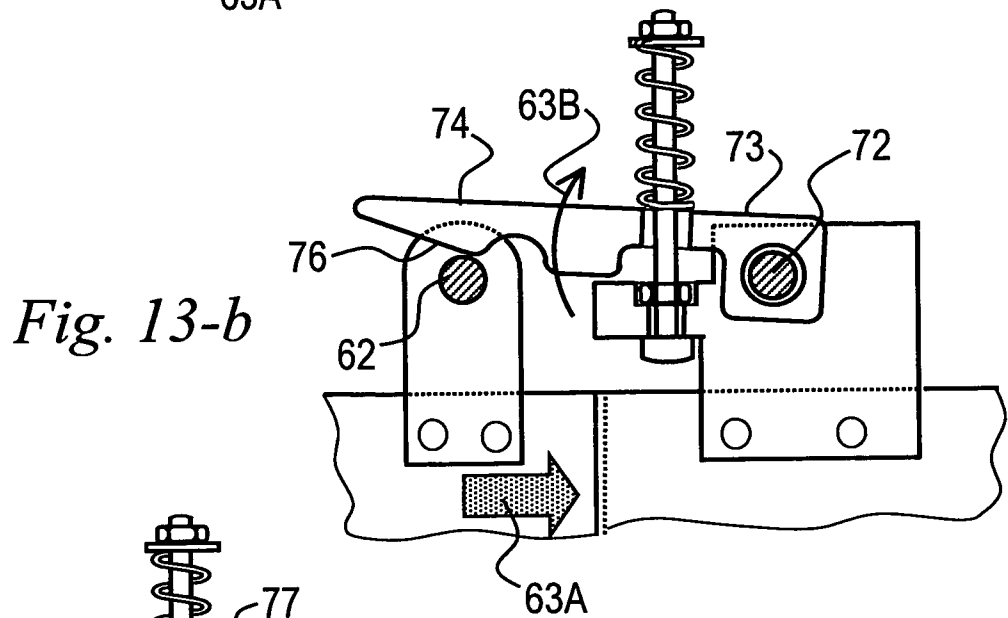
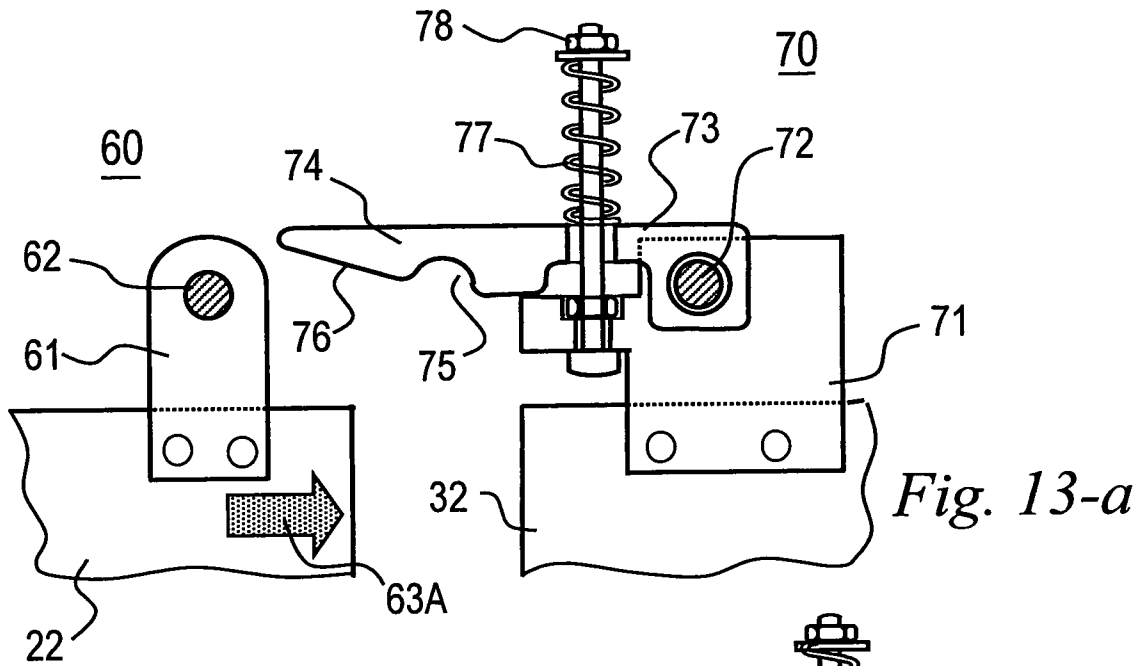
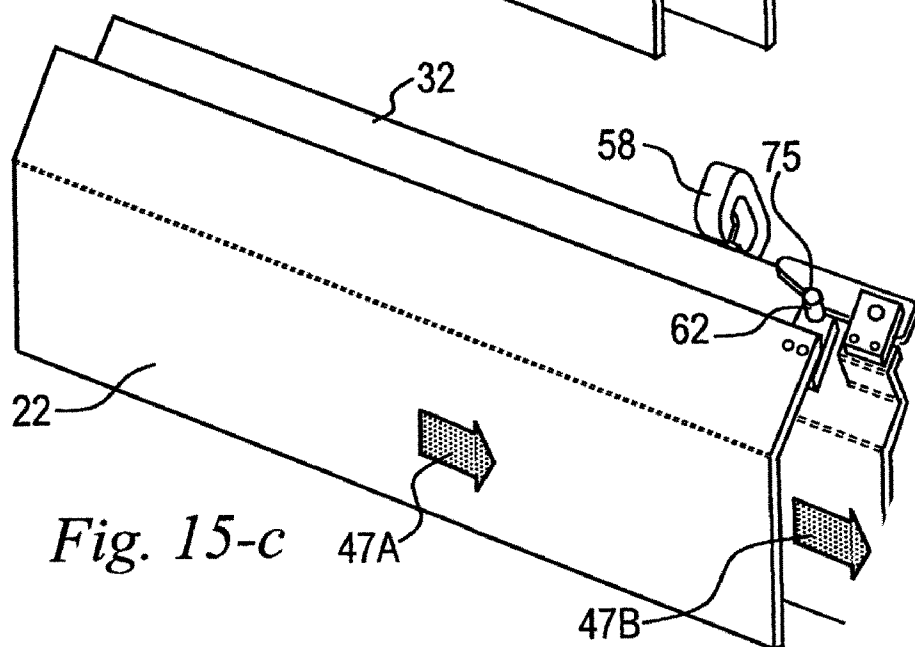
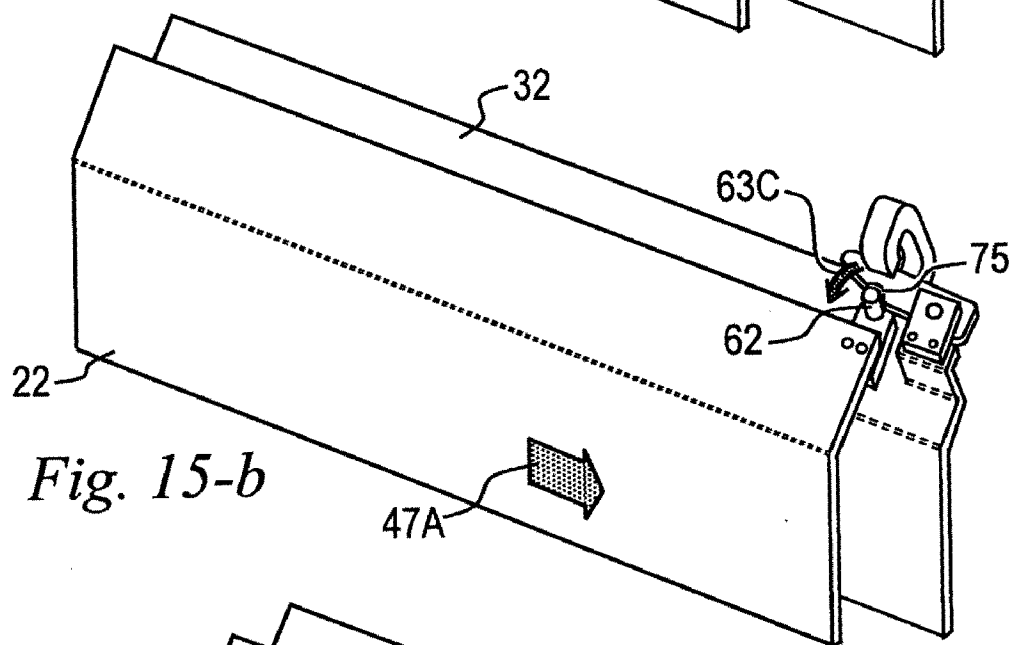
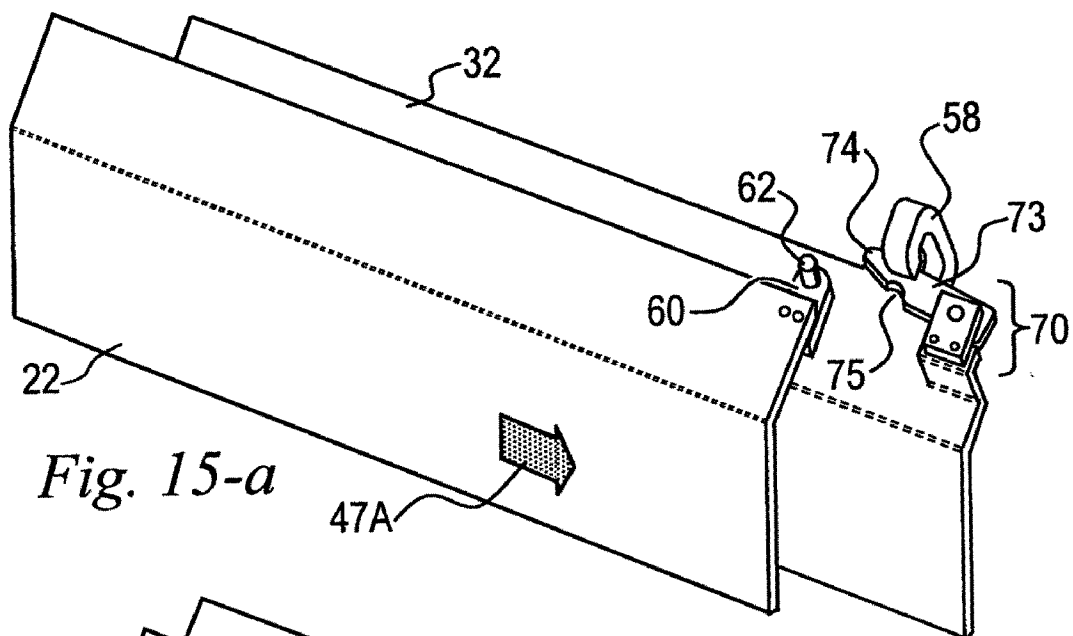


*Fig. 14*





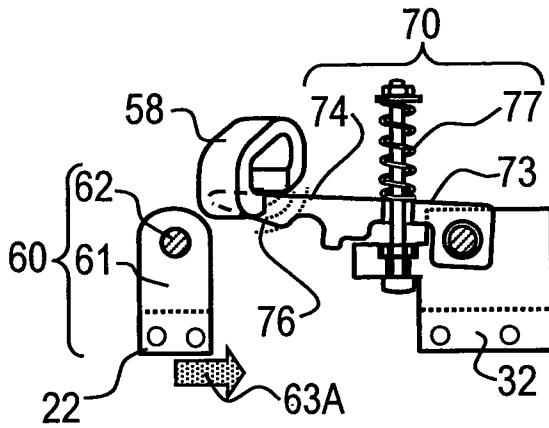


*Fig. 16-a*

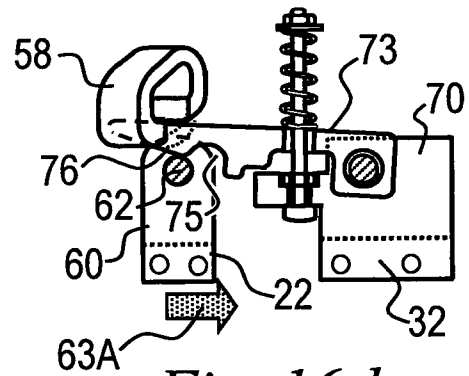


*Fig. 16-b*

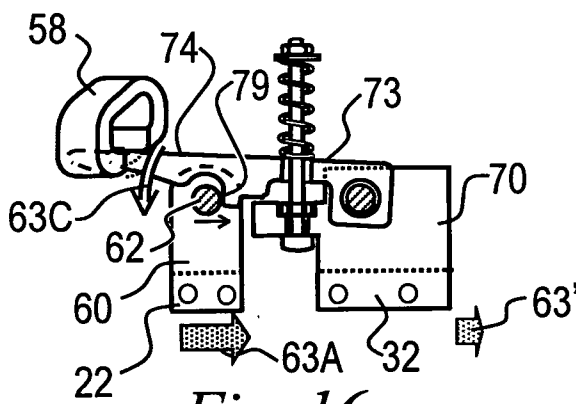


*Fig. 16-c*

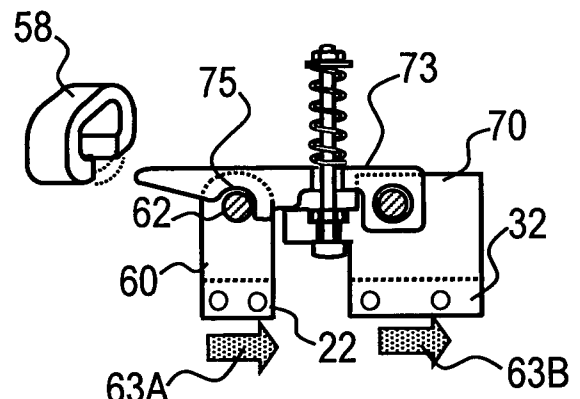


*Fig. 16-d*

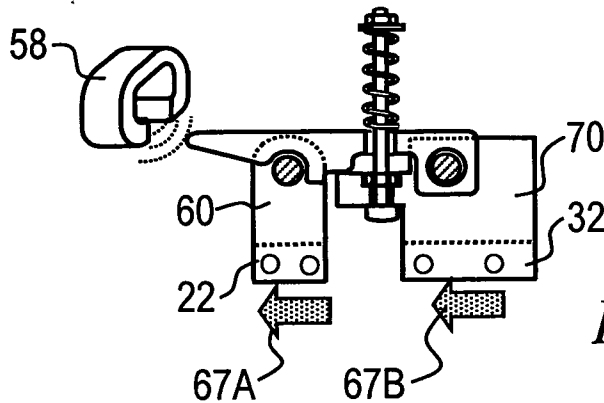


*Fig. 16-e*

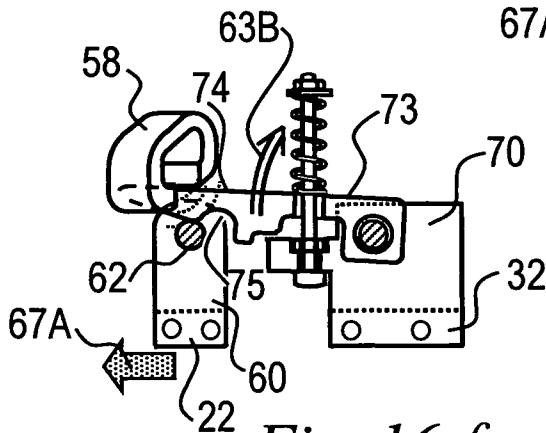


*Fig. 16-f*

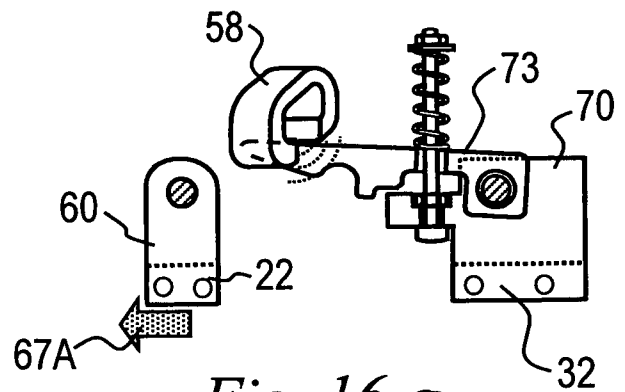


*Fig. 16-g*

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/BR 2009/000193

## A. CLASSIFICATION OF SUBJECT MATTER

IPC<sup>8</sup>: **B66B 13/08** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC<sup>8</sup>: B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                           | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | JP 2000-318958 A (MITSUBISHI ELECTRIC CORP)<br>21 November 2000 (21.11.2000)<br><i>Abstract; Fig. 13, 14</i> | 1, 15                 |
| X         |                                                                                                              | 16, 17, 21, 24,<br>25 |
|           | --                                                                                                           |                       |
| A         | US 5 584 365 A (TONNA) 17 December 1996 (17.12.1996)                                                         |                       |
|           | ----                                                                                                         |                       |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"&amp;" document member of the same patent family

Date of the actual completion of the international search  
03 March 2010 (03.03.2010)Date of mailing of the international search report  
16 March 2010 (16.03.2010)Name and mailing address of the ISA/ AT  
**Austrian Patent Office**  
Dresdner Straße 87, A-1200 ViennaAuthorized officer  
**NIMMERRICHTER R.**

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/BR 2009/000193**

| Patent document cited<br>in search report |   |            | Publication<br>date | Patent family<br>member(s) |   |            | Publication<br>date |
|-------------------------------------------|---|------------|---------------------|----------------------------|---|------------|---------------------|
| JP                                        | A | 2000318958 |                     | JP                         | A | 2000318958 | 2000-11-21          |
| US                                        | A | 5584365    |                     | JP                         | A | 8099787    | 1996-04-16          |
|                                           |   |            |                     | US                         | A | 5584365    | 1996-12-17          |