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3,605,952

DOOR COUPLING APPARATUS FOR ELEVATOR SYSTEMS

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2 Sheets-Sheet 1

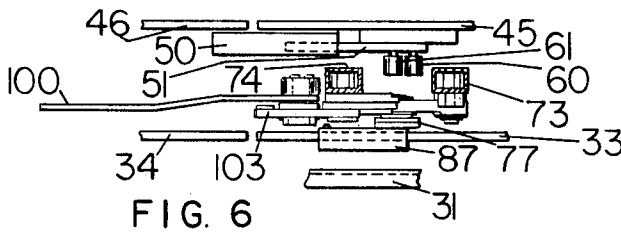


FIG. 6

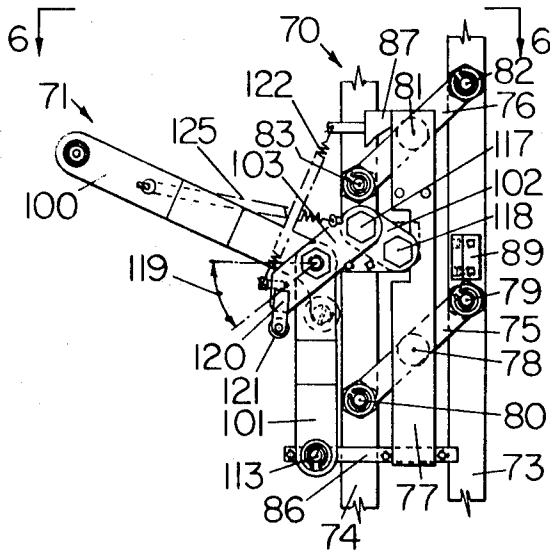


FIG. 5

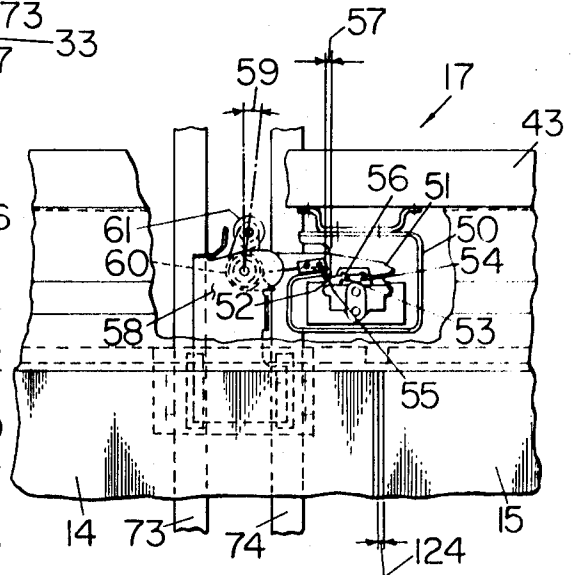


FIG. 3

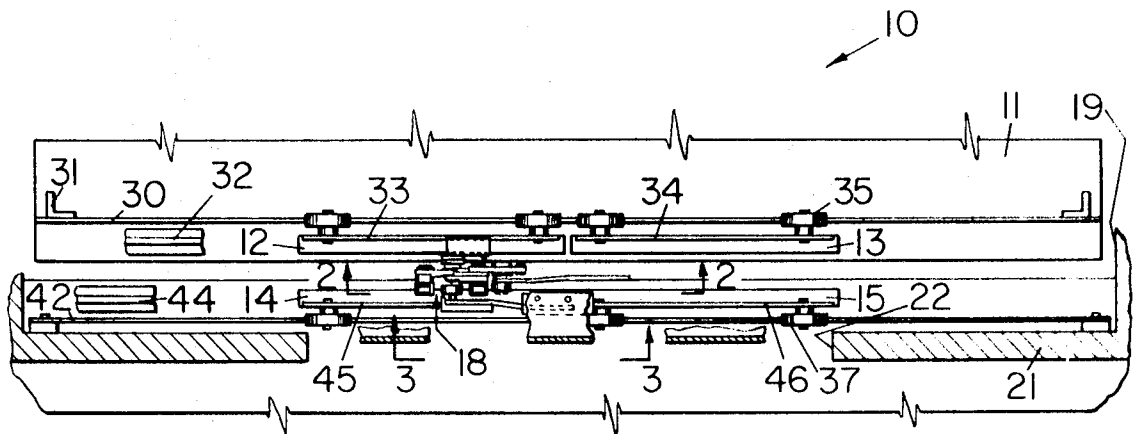


FIG. 1

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2 Sheets-Sheet 2

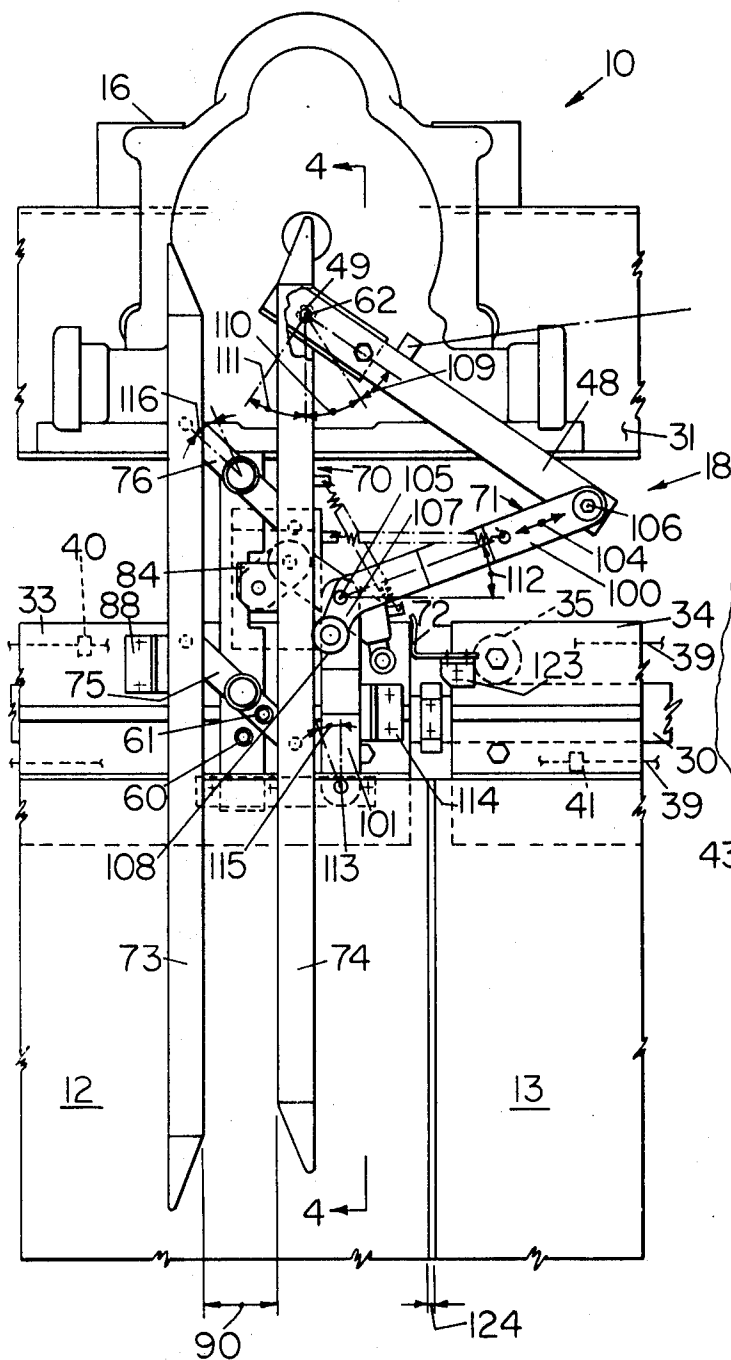


FIG. 2

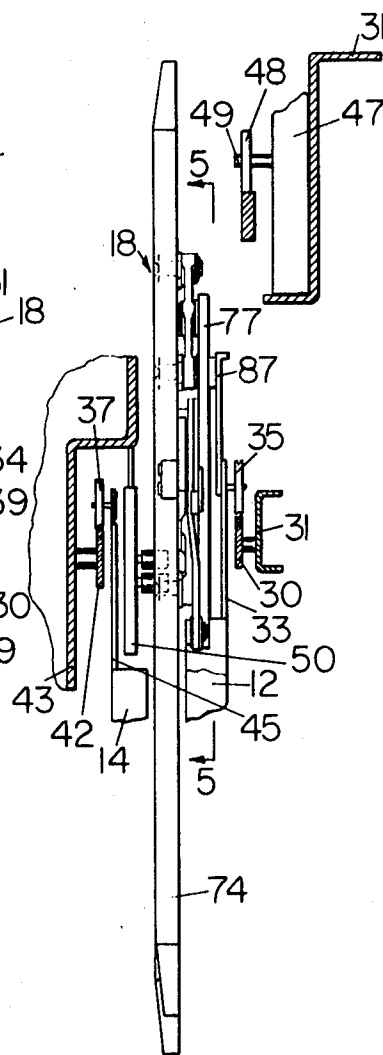


FIG. 4

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3,605,952
**DOOR COUPLING APPARATUS FOR
ELEVATOR SYSTEMS**

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16 Claims

ABSTRACT OF THE DISCLOSURE

A door coupling apparatus for an elevator system for coupling and driving an elevator car door and a hoistway door of an elevator system for simultaneous movement of the doors between open and closed positions. The door coupling apparatus includes a vane assembly, which is mounted on the car door coupling the hoistway door thereto, and includes an elongate link assembly which has one end thereof connected to the vane assembly for urging the vane assembly to couple the doors and for latching the vane assembly after the doors are coupled together. The door coupling apparatus also includes a door operating mechanism which is connected to the other end of the link assembly for driving the coupled doors between the open and closed positions. The door coupling apparatus also includes a releasing member arranged to engage the link assembly after the coupled doors reach the closed position for unlatching the vane assembly and for uncoupling the doors in the closed position.

The present invention relates to a door coupling apparatus for an elevator system, and particularly to a door coupling apparatus for an elevator system having a pair of coupling vanes.

An elevator system of conventional construction includes an elevator car serving a plurality of floor landings, a car door mounted on said elevator car for horizontal sliding movement between open and closed positions, a hoistway door at each of said landings mounted for horizontal sliding movement parallel to the movement of said car door, and a door operating mechanism mounted on said car and connected operatively to said car door. Said conventional elevator system also includes an interlock mechanism operative to lock said hoistway door in its closed position, and includes a coupling apparatus operatively effective in response to actuation of said door operating mechanism to cooperatively couple said doors for simultaneous opening and closing thereof by said door operating mechanism.

A conventional coupling apparatus and interlock mechanism is described in U.S. Pat. No. 3,065,826, issued Nov. 27, 1962, which is assigned to the same assignee as in this application. The conventional apparatus includes a vane assembly, which is mounted on the car door and which couples a roller that is mounted on the hoistway door. The conventional vane assembly is held in its closed or coupling position by a latch member, which is pivotally mounted on the car door. The latch member is spring biased to latch the vane assembly; and the latch member is rotated by a fixed stop to unlatch the vane assembly. The fixed stop is mounted on the car framework and is disposed above the car door. In closing the car and hoistway doors, the fixed stop applies a substantial force against the latch and rotates the latch as the car door moves past the fixed stop thereby unlatching the vane assembly. The fixed stop requires a certain distance of movement of the car door relative to the car in order to rotate the latch and to disengage the latch from the vane assembly when closing the doors. In one

model of the conventional coupling apparatus this distance was about three inches. With this conventional construction, the vane assembly uncouples the hoistway door from the car door while the hoistway door is still slightly open during the closing movement of the doors, and the fixed stop applies a substantial force against the latch, which urges the car door away from its closed position.

With the conventional coupling apparatus and interlock mechanism, it is difficult to minimize the cycle time for opening and closing the car and hoistway doors, and it is difficult to provide for an optimum rate of deceleration in the final closing movement of the hoistway door. In addition, with the conventional coupling apparatus and interlock mechanism, it is difficult to avoid an interruption in the operation of the elevator if a relatively large friction force is applied to the hoistway door because such friction force can hold the hoistway door in a slightly open position during the closing movement of the door after the hoistway door is uncoupled.

In accordance with one embodiment of the present invention, by using an elongate link assembly, or jointed thrust member, which is disposed between the vane assembly and the door operating mechanism and which includes a drive link that drives the vane assembly and which includes a pair of latching links that restrain the vane assembly against uncoupling until the doors reach the closed position, the vane assembly can uncouple the hoistway door from the car door and the interlock mechanism can simultaneously lock the hoistway door as the hoistway door reaches its closed position. In this way, the elevator performance is improved because the opening and closing cycle time of the doors can be minimized and an optimum closing deceleration rate for the hoistway door can be provided. In addition, the elevator operation cannot be interrupted by the application of a friction force on the partly opened hoistway door. Moreover, because the pair of latching links of the link assembly rely on a bearing type of latching force, instead of a frictional type of latching force, the latching force does not lessen due to wearing of the parts or due to dirt deposits on the working surfaces. Thus, the hazard of faulty operation of the door coupling apparatus is minimized. Further, the need for additional latching mechanisms is avoided.

Accordingly, it is one object of the invention to provide an elevator system having an elevator car door and hoistway door coupling apparatus which is operative to uncouple or to couple the hoistway door to the car door when the hoistway door is in its fully closed position.

It is another object of the invention to provide an elevator car door and hoistway door coupling apparatus according to the aforementioned object, which has an interlock mechanism that coacts therewith to simultaneously uncouple and lock or to simultaneously couple and unlock the hoistway door.

It is still another object of the invention to provide an elevator car door and hoistway door coupling apparatus according to the aforementioned objects, which continues to couple together the car door and hoistway door when closing the doors until the hoistway door is within an interlock zone, and thereafter rapidly releases the interlock lever to permit fast locking of the hoistway door.

It is a further object of the invention to provide an elevator car door and hoistway door coupling apparatus according to the aforementioned objects, which has a thrust member interconnecting the vane assembly and the door operating mechanism that is operative to not only drive the doors and the vane assembly but also that is operative to latch and unlatch the vane assembly for coupling and uncoupling the doors.

It is a still further object of the invention to provide an elevator car door and hoistway door coupling apparatus according to the aforementioned objects, wherein the thrust member can be made from a plurality of mechanical links.

According to the present invention, there is provided a door coupling apparatus for an elevator system for coupling a door of an elevator car to a hoistway door and for unlocking the hoistway door for simultaneous displacement of said doors between open and closed positions, said door coupling apparatus comprising, door operating means mounted on said elevator car for operating said doors, interlock means mounted on said hoistway door for locking said hoistway door in said closed position, vane means pivotally mounted on said car door and being movable relative thereto between coupling and uncoupling positions, said vane means being operative in its coupling position to couple said interlock means for unlocking said hoistway door and for coupling said hoistway door to said car door for simultaneous displacement of said doors between said open and closed positions, and an elongate force transmitting means connected at one end thereof to said door operating means and connected at the other end thereof to said vane means for transmitting an operating force from said door operating means to said vane means, wherein said force transmitting means includes latching means, said latching means being operative to latch said vane means when said vane means is in its coupling position.

Other objects of the invention will become apparent upon reading the following description and accompanying drawings, wherein like parts are designated by like numerals throughout the several views, and wherein:

FIG. 1 is a partial top plan view of an elevator system embodying features of the present invention;

FIG. 2 is a sectional view as taken along the line 2—2 of FIG. 1;

FIG. 3 is a sectional view as taken along the line 3—3 of FIG. 1;

FIG. 4 is a sectional view as taken along the line 4—4 of FIG. 2;

FIG. 5 is a sectional view as taken along the line 5—5 of FIG. 4; and

FIG. 6 is a sectional view as taken along the line 6—6 of FIG. 5.

Referring to FIG. 1, one embodiment of the present invention is an elevator system 10. Elevator system 10 includes an elevator car 11, a pair of center-opening car doors 12, 13 which are movable in a horizontal direction relative to elevator car 11 and includes a pair of center-opening hoistway doors 14, 15, which are also movable in a horizontal direction parallel to the movement of the elevator car doors 12, 13.

Elevator system 10 also includes a door operating or drive mechanism 16 (FIG. 2), which is mounted on elevator car 11 and which is connected operatively to elevator car door 12. Elevator system 10 also includes an interlock mechanism 17 (FIG. 3), which is operative to lock hoistway doors 14, 15 in a fully closed position. Elevator system 10 also includes a coupling apparatus 18 (FIG. 2), which couples car door 12 to hoistway door 14 for simultaneous movement of car doors 12, 13 and hoistway doors 14, 15. Elevator car 11 is disposed in a hoistway 19 and serves a floor landing, which is one of a plurality of similar floor landings. Hoistway 19 is enclosed by a hoistway wall 21, which has a door opening 22 at the illustrated floor landing.

Car doors 12, 13 (FIG. 2) are supported by an overhead track 30 (FIG. 1), which is mounted on a structural framework 31 of elevator car 11. Car doors 12, 13 are also guided by a sill plate 32 of conventional construction, which is disposed at the bottom thereof. Car doors 12, 13 have respective hanger plates 33, 34 which are fixedly connected at the top of doors 12, 13. Hangers 33, 34 have respective pairs of upper anti-friction rollers

35, which ride on the top of track 30 for movement of the doors between open and closed positions. Car doors 12, 13 are interconnected by a conventional type of wire cord 39 to assure that a cooperating motion and force is transmitted to car door 13 by car door 12. Wire cord 39, which forms a continuous loop passover a pair of pulleys (not shown), and is securely fastened by a first connector 40 to car door 12 and by a second connector 41 to car door 13 in a conventional manner.

Hoistway doors 14, 15 (FIG. 1) are similarly supported by an overhead track 42. Track 42 is fixedly connected to a wall header member 43 (FIG. 4), which is disposed above door opening 22. Hoistway doors 14, 15 are similarly guided by a conventional sill plate 44 (FIG. 1), which is disposed at the bottom thereof. Hoistway doors 14, 15 also have respective hanger plates 45, 46, which have respective pairs of upper anti-friction rollers 37 for moving the doors between open and closed positions. The hoistway doors 14, 15 are similarly interconnected by a wire cord (not shown), which passes over spaced pulleys (not shown) for transfer of motion from hoistway door 14 to hoistway door 15.

Door operating mechanism 16 (FIG. 2) includes a motor 47 (FIG. 4), such as a combination high-speed and spaced reducer or the like, which is mounted on the car framework 31. Motor 47 has a reciprocating crank arm 48, which is fixedly connected at one end thereof to the motor shaft 49 for rotation about the axis 62 thereof.

Interlock mechanism 17 (FIG. 3), which is a switching and latching mechanism, includes a switch housing 50 which is fixedly mounted on wall header 43, and includes a locking lever or detent 51, which is rotatably mounted on hoistway door 14 and which is received by housing 50. When hoistway doors 14, 15 are closed, interlock mechanism 17 is operative to lock together hoistway doors 14, 15 and is also operative for enabling power to be supplied through a switch to elevator car 11 as explained hereafter. Interlock mechanism 17 cooperates with coupling apparatus 18, which is driven by door operating mechanism 16. Cooperation of door operating mechanism 16, interlock mechanism 17 and coupling apparatus 18 is more fully described hereafter.

Switch housing 50 (FIG. 3) is fixedly connected to wall header 43, and has a catch surface 52 for locking lever 51 in place. Switch housing 50 also has a pair of spaced interlock switch contacts 53, 54. Lever 51 has a latch surface 51 that cooperates with catch surface 52 for locking lever 51 and has a bridging contact 56 on the underside thereof, which cooperates with switch contacts 53, 54 to form a safety switch in a circuit supplying power to elevator car 11. FIGS. 1 through 6 show car and hoistway doors 12, 13, 14, 15 disposed in their closed position. In such condition, lever 51 is locked in place inside housing 50 and latch surface 55 is separated from catch surface 52 by a clearance 57 forming an interlock zone. Lever 51 (FIG. 3) is rotatably mounted on a plate 58, which is attached to door 14, and lever 51 is displaceable through an angle 59. Lever 51 is urged by the force of gravity to assume a horizontal position. Lever 11 has a primary coaxial roller 60 and secondary offset roller 61, which are rotatably mounted on lever 51 and which cooperate with coupling apparatus 18 as explained hereafter.

Coupling apparatus 18 (FIG. 2) includes a vane assembly 70, which is mounted on car door 12 for coupling rollers 60, 61, a link assembly, or thrust device 71, which connects crank arm 48 to vane assembly 70 for driving and latching vane assembly 70, and a releasing device 72, which is mounted on car door 13 for unlatching vane assembly 70.

Vane assembly 70 (FIG. 2) includes a pair of vertically disposed elongate vanes 73, 74, a pair of pivot arms 75, 76, which support vanes 73, 74, and a rear support plate 77 (FIG. 5), which supports pivot arms 75, 76. Vanes 73, 74 are disposed on opposite sides of hoistway

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therebetween. Roller 60 has an outer diameter which is door rollers 60, 61, in order to loosely clamp said rollers equal to or slightly more than the outer diameter of secondary roller 61 for ease of vertical alignment of rollers 60, 61 by vanes 73, 74.

Support plate 77 at its lower end is fixedly mounted on door hanger plate 33 and extends upwardly therefrom. Pivot arm 75 has a center anti-friction pivot 78 (FIG. 5) which is supported by plate 77 and has a pair of end pivots 79, 80, which respectively support vanes 73, 74. Pivot arm 76 has a similar center pivot 81, which is supported by plate 77, and also has a similar pair of end pivots 82, 83 which respectively support vanes 73, 74. With this construction, vanes 73, 74 can move in parallelogram fashion, toward and away from rollers 60, 61, which are disposed therebetween, in order to loosely clamp and couple in a coupling position, or separate from and uncouple said rollers in an uncoupling position. Vane 74 also has an integral plate 84 (FIG. 2) which is connected to link assembly 71 for support thereof.

When secondary roller 61 is loosely clamped by vanes 73, 74, interlock lever 51 is mounted through angle 59 whereby rollers 60, 61 are substantially aligned in a vertical direction. When rollers 60, 61 are so aligned, interlock latching surfaces 52, 55 and switch contacts 56 and 53, 54 are disengaged. In this way, when vanes 73, 74 loosely clamp rollers 60, 61, car and hoistway doors 12, 14 are coupled and interlock mechanism 17 is unlocked. Also, when vanes 73, 74 release rollers 60, 61, car and hoistway doors 12, 14 are uncoupled and interlock mechanism 17 is locked. Thus, coupling apparatus 18 and interlock mechanism 17 cooperate to couple and unlock and also to uncouple and lock said coupled car and hoistway doors 12, 14 for the opening and closing thereof. The operation of coupling apparatus 18 and interlock 17 is described in more detail hereafter.

Support plate 77 has an integral, horizontal, plate portion 86 at the bottom end thereof, which is fixedly connected to hanger plate 33. Support plate 77 also has a support bracket 87 at the top end thereof, which is fixedly connected to hanger plate 33. Vane assembly 70 (FIG. 2) also has a first limit stop 88, which is mounted on door hanger 33 for engaging vane 73 and has a second limit stop 89 (FIG. 5), which is mounted on vane 73 at the rear side thereof for engaging plate 84. Stops 88, 89 limit the amount of travel of vanes 73, 74. In this way, the amount of travel of vanes 73, 74 toward and away from rollers 60, 61 is limited by stops 88, 89.

Vanes 73, 74 (FIG. 2) are separated by a distance 90, which varies from a minimum amount when second stop 89 engages support plate 77 through a maximum amount when vane 73 engages first stop 88. Distance 90 varies from a maximum size, which includes suitable running clearances between the outer surfaces of main roller 60 and the inner sides of vanes 73, 74, to a minimum size which permits rotary movement of rollers 60, 61 when engaged by vanes 73, 74. The corresponding rollers on all hoistway doors in hoistway 19 are vertically aligned with rollers 60, 61 to provide similar running clearances therewith.

Link assembly 71 (FIGS. 2 and 5) is a thrust means and a force transmitting means, which interconnects vane plate 84 and crank arm 48. Link assembly 71 has a first elongate drive link or lever 100 for actuating vane assembly 70, a second guide link 101 for guiding and supporting drive link 100, and third and fourth latching links 102, 103 for latching vane assembly 70 in its closed or door coupling position.

Drive link 100 also has a lever portion 107, which 104 from crank arm 48 to vane assembly 70 for driving doors 12, 13, 14, 15 between the open and closed positions. Drive link 100 and guide link 101 also cooperate with latching links 102, 103 for latching vanes 73, 74 when vanes 73, 74 are coupled to rollers 60, 61. Drive

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link 100 has a first pivot shaft or pin 105 (FIG. 2) near an intermediate portion thereof, which is pivotally connected to and supported by guide link 101. Drive link 100 also has a second pivot shaft 106 near an end portion thereof, which is pivotally connected to crank arm 48. Shafts 105, 106 are disposed substantially parallel to each other and to crank axis 62.

Drive link 100 also has a lever position 107, which projects therefrom near first pivot shaft 105. Lever portion 107 transmits drive force 104 from crank arm 48 to vane 74. Lever portion 107 has an anti-friction drive roller 108 which is rotatably mounted thereon for bearing against vane 74 and for operating latching links 102, 103.

Crank arm 48 in its forward stroke rotates clockwise (FIG. 2) through first angle 109, just prior to the movement of doors 12, 13, 14, 15 from the closed to the open position. As crank arm 48 moves through first angle 109, drive roller 108 bears against and transmits drive force 104 to vane 74 thereby closing vanes 73, 74. As vanes 73, 74 close, the distance 90 between vanes 73, 74 is reduced to a minimum size. In this way, vanes 73, 74 couple rollers 60, 61 and open interlock lever 51 before doors 12, 13, 14, 15 begin to open. In continuing the forward stroke, crank arm 48 rotates through a second angle 110 until crank arm 48 approaches a substantially vertical position. In this position, latching links 102, 103 latch vanes 73, 74. Crank arm 48 then rotates through third angle 111 in order to complete the forward stroke for opening doors 12, 13, 14, 15. During the movement of crank arm 48 through first angle 109 and second angle 110, drive link 100 rotates clockwise through angle 112 and drive roller 108 bears against vane 74 and transmits drive force 104 to vane 74. When crank arm 48 moves through third angle 111, drive link 100 rotates in a counterclockwise direction through angle 112 so that drive roller 108 does not bear against vane 74. Instead, drive force 104 is transmitted through latching links 102, 103 to vane 74. In this way, vanes 73, 74 couple and open doors 12, 13, 14, 15.

Guide link 101, which is disposed in an approximately vertical position prior to rotation of crank arm 48, has a third pivot shaft 113 at the lower end thereof, which is pivotally connected to door 12 for limited angular displacement of guide link 101 about third pivot shaft 113. Guide link 101 is connected at the upper end thereof to first drive link 100 by first pivot pin 105. Guide link 101 also has a fixed stop 114 (FIG. 2), which is arranged to limit the angular displacement of guide link 101 when crank arm 48 rotates counterclockwise on the closing stroke of door 12 (FIG. 2). Fixed stop 114 is fixedly mounted on car door hanger 33. Fixed stop 114 is positioned so that guide link 101 bears against fixed stop 114 and transmits a part of drive force 104 from drive link 100 through guide link 101 to fixed stop 114 on the closing stroke of doors 12, 13.

Guide link 101 (FIG. 2) is acted on by first drive link 100 during the opening stroke of door 12. Guide link 101 is urged to rotate through an angle 115 during the opening stroke of door 12. In such rotation, guide link 101 moves away from fixed stop 114 and rotates about the axis of pivot shaft 113. In the opening stroke of door 12, guide link 101 moves through angle 115 in a counterclockwise direction (FIG. 2) away from fixed stop 114, when crank arm 48 rotates clockwise through angle 109. At the same time, drive link 100 bears on vane 74 and rotates vane pivot arm 76 through an angle 116. In this way, vanes 73, 74 are urged to clamp rollers 60, 61 and to rotate interlock lever 51 through lock angle 59 (FIG. 3). Thus, car and hoistway doors 12, 14 are coupled and hoistway doors 14, 15 are unlocked while doors 14, 15 are still fully closed just prior to the opening stroke of doors 12, 13, 14, 15.

Latching links 102, 103 (FIGS. 2 and 5), which form a broken-arm type of linkage, are interconnected

by a fourth pivot shaft 117 at the adjacent ends thereof. Latching link 102 also has a fifth pivot shaft 118 at the opposite end thereof, which is pivotally connected to vane plate 84. Pivot shafts 113, 117, 118 are substantially parallel to each other and to crank axis 62.

Latching links 102, 103 are operative to latch vanes 73, 74 in their closed position during the opening stroke of door 12. As crank arm 48 approaches the end of angle 110 in the clockwise rotation (FIG. 2) thereof, latching links 102, 103 move vertically downward into a substantially straight or aligned position thereby latching vanes 73, 74 in a closed position. Latching link 103 moves approximately through an angle 119 as latching links 102, 103 move downward into the straight or aligned position. Thus, during the opening stroke of door 12, as crank arm 48 moves through angle 110, latching link 103 moves through angle 119 for latching vanes 73, 74 in their closed position. In such position, dimension 90 between vanes 73, 74 has a minimum size. With this construction, latching links 102, 103 provide a snap-action latching action on vanes 72, 73 when crank arm 48 is near to its vertical position near the end of angle 110.

Latching link 103 also has a trip portion 120 (FIG. 5), which projects beyond first pivot shaft 105 for engaging releasing device 72 (FIG. 2). Trip portion 120 has a roller 121, which is rotatably mounted thereon. Trip roller 121 cooperates with releasing device 72 as explained hereafter.

When crank arm 48 is moving through its forward stroke and is rotating clockwise (FIG. 2) through its first angle 109 and part of its second angle 110, latching links 102, 103 have an unlatched and bent shape. After crank arm 48 reaches the end portion of second angle 110 so that crank arm 48 is in a substantially vertical position, and after drive link 100 and drive roller 108 have rotated through angle 112 about first pivot shaft 105 so that guide link 101 rests against stop 114, latching links 102, 103 acquire a straight aligned shape. That is, during the opening stroke of door 12, drive link 100 moves through angle 112 in a clockwise direction (FIG. 2), guide link 101 moves through angle 115 in a clockwise direction relative to vane 74, and latching link 103 moves through angle 119 in a counterclockwise direction (FIG. 2) until latching links 102, 103 reach the aligned position.

Latching link 103 also has a tension-type latch spring 122 (FIG. 5), which urges latching vanes 102, 103 to move downward into a straight, aligned latching position and which provides a final snap-action movement in links 102, 103. In this way, vanes 73, 74 are latched by latching links 102, 103 before crank arm 48 continues in a clockwise direction (FIG. 2) through third angle 111. It is also noted that in the closing stroke of door 12, crank arm 48 rotates in a counterclockwise direction through angles 109, 110, 111 and returns to its original position. In such position, doors 12, 13, 14, 15 are substantially in a fully closed position, as explained hereafter.

Latch spring 122 is connected at one end to support bracket 87 and is connected at the opposite end to latching link 103 adjacent trip roller 121. Latch spring 122 applies a pulling force on latching link 103 for urging latching link 103 to rotate about pivot shaft 105 and for urging latching links 102, 103 into a substantially aligned or straight position.

Releasing device 72 is a tripping cam, such as a bent plate. Cam 72 is supported by a support member 123, such as a clip angle, which is fixedly connected to door hanger 34. Cam 72 is arranged to engage trip roller 121 in order to urge link 103 in a clockwise direction (FIG. 2) for unlatching links 102, 103 and for unlatching vane 74. When doors 12, 13 reach a substantially closed position, cam 72 engages roller 121 thereby unlatching vanes 73, 74 and uncoupling rollers 60, 61.

Cam 72 is adjustably connected to clip angle 123 so

that cam 72 can be positioned to engage trip roller 121 just as car and hoistway doors 12, 13, 14, 15 reach a fully closed position. In the closed position, the leading edges of car doors 12, 13 and hoistway doors 14, 15 are separated by a slight gap 124, which is not more than a predetermined maximum size. Interlock clearance 57 is preferably equal to one-half of gap 124. Cam 72 is arranged so that roller 121 is tripped within the interlock zone of clearance 57. In one model of embodiment 10, interlock clearance 57 was not more than three-sixteenths of an inch (0.187 inch) and gap 124 between the leading edges of three-eighths was not more than three-eighths of an inch (0.375 inch) in their closed position. With such construction, hoistway doors 14, 15 can be fully closed within the interlock clearance 57 before vane assembly 70 is unlatched and before doors 12, 13, 14, 15 are uncoupled.

During the closing stroke of door 12, crank arm 48 exerts a pulling type of drive force 104 which is transmitted through latching links 102, 103 to vane 74. Within the interlock zone of clearance 57, cam 72 engages roller 121 thereby tripping links 102, 103 and unlatching vanes 73, 74. Vane 74 has an elongate tension spring 125 (FIG. 5) which urges vanes 73, 74 toward their open position wherein dimension 90 between vanes 73, 74 has a maximum size. Vane spring 125 is connected at one end to vane 74 and at the other end thereof to drive link 100.

FIGS. 1 through 6 show car doors 12, 13 and hoistway doors 14, 15 in their fully closed, stationary position. In this position, vanes 73, 74 are fully separated and elevator car 11 is in condition to move to another floor landing or to stay at floor landing 20 and to open doors 12, 13, 14, 15. The operation of opening and closing doors 12, 13, 14, 15 at floor landing 20 is explained hereafter.

In operation, the door opening sequence is as indicated hereafter.

(1) Crank arm 48 is rotated by motor 47 in a clockwise direction through angle 109. Arm 48 exerts a pushing force 104 against drive link 100 which is transmitted to vane 74 by drive roller 108. Force 104 rotates pivot arms 75, 76 in a clockwise direction (FIG. 2) through angle 116 thereby urging vanes 73, 74 toward each other and reducing the size of distance 90 to a minimum. At the same time, force 104 also rotates guide link 101 about pivot shaft 113 in a counterclockwise direction through angle 115.

(2) As vanes 73, 74 move toward each other, vanes 73, 74 engage rollers 60, 61 and rotate interlock lever 51 in a counterclockwise direction through angle 59 (FIG. 3) thereby unlocking lever 51 from housing 50 and separating switch contacts 53, 54 from bridging contact 56.

(3) Thereafter, stop 89 engages plate 84 and stops the travel of vanes 73, 74 so that vanes 73, 74 fully couple interlock rollers 60, 61 in a loosely clamped condition. In this condition, drive force 104 is transmitted from drive roller 108 through vane 74 and plate 77 to closed door 12.

(4) Then crank arm 48 rotates clockwise (FIG. 2) through angle 110 and opens doors 12, 13, 14, 15. Drive link 100 simultaneously rotates through angle 112, guide link 101 simultaneously rotates backwardly through angle 115 and latching link 103 rotates through angle 119. Near the end of travel of crank arm 48 through angle 110, when crank arm 48 is in a substantially vertical position, latching links 102, 103 snap into an aligned or straight latching position.

(5) Thereafter, crank arm 48 rotates clockwise through angle 111, and continues to open doors 12, 13, 14, 15. Drive link 100 simultaneously rotates counterclockwise through angle 112 thereby separating roller 108 from vane 74. Force 104 is transmitted through links 102, 103 to vane 74. Part of force 104 is transmitted from vane 74 through plate 77 to door 12, and part of force 104 is transmitted from vane 74 through roller 60 to door 14 for urging doors

12, 14 to the fully open position. In this way, doors 12, 13, 14, 15 are moved to the open position. It is also noted that the leading edges of respective doors 12, 14 and 13, 15 are substantially flush or aligned when moving from the closed to the open position.

In operation, the door closing sequence is as indicated hereafter.

(1) Motor 47 rotates crank arm 48 in a counterclockwise direction through angles 111, 110, 109. Arm 48 exerts a pulling force 104 on link 100, which passes through links 102, 103 into vane 74. It is noted that respective doors 12, 14 and 13, 15 are also aligned along their leading edges during their closing movement.

(2) As doors 12, 13, 14, 15 move into the fully closed position, interlock catch surface 55 passes beyond and clears latch surface 52 approximately by clearance 57 (FIG. 3). When doors 12, 13, 14, 15 are in such interlock zone within clearance 57, cam 72 engages trip roller 121 and trips link 103 thereby unlatching vanes 73, 74. Vane spring 125 snaps open vanes 73, 74 so that dimension 90 is enlarged to a maximum size.

(3) Vanes 73, 74 separate thereby uncoupling rollers 60, 61. Interlock lever 51 rotates through angle 59, bridging contact 56 engages switch contacts 53, 54 thereby connecting a power supply circuit to elevator car 11. In addition, latch surface 55 hooks over catch surface 55 thereby locking hoistway doors 14, 15. In this way, car and hoistway doors 12, 13, 14, 15 are simultaneously uncoupled and locked when closing upon returning to substantially the same position within the interlock zone at which the doors were previously coupled and unlocked when opening.

With the construction according to the invention, link assembly 71 actuates vane assembly 70 in the opening stroke of doors 12, 14 so as to start the motion of doors 12, 14 at substantially the same instant and also so as to open interlock mechanism 17 before motion of either door 12 or 14. In addition, link assembly 71 actuates vane assembly 70 in the closing stroke of doors 12, 14 so as to keep doors 12, 14 coupled to each other and to operating mechanism 16 until door 14 is within the interlock zone 57 and so as to rapidly release the interlock lever 51 within the interlock zone 57. Moreover, link assembly 71 not only drives but also latches vane assembly 70 when coupling rollers 60, 61 so that additional latching mechanisms, such as electromechanical latching mechanisms, are not required. With such construction, interruptions in the operation of the elevator 11, which are caused by friction forces on the hoistway doors 14, 15, are minimized. In addition, the hazard of breakdown of the coupling apparatus due to dirt deposits on its parts, or due to vibration or like overstresses in the parts, or due to wearing of the parts, is minimized.

A preferred embodiment 10 has been described in detail and many modifications thereto may occur to those skilled in the art. It is intended that the particular embodiment which has been described be typical of all such modified embodiments. For example, an alternate embodiment of the elevator installation according to the invention can have single car and hoistway doors in place of center-opening car doors and hoistway doors.

What is claimed is:

1. A door coupling apparatus for an elevator system for coupling a door of an elevator car to a hoistway door and for unlocking the hoistway door for simultaneous displacement of said doors between open and closed positions,

said door coupling apparatus comprising,

door operating means mounted on said elevator car for operating said doors,

interlock means mounted on said hoistway door for locking said hoistway door in said closed position, vane means pivotally mounted on said car door and being movable relative thereto between coupling and uncoupling positions, said vane means being op-

erative in its coupling position to couple said interlock means for unlocking said hoistway door and for coupling said hoistway door to said car door for simultaneous displacement of said doors throughout their movement in both the opening and closing directions between said open and closed positions, and an elongate force transmitting means connected at one end thereof to said door operating means and connected at the other end thereof to said vane means for transmitting an operating force from said door operating means to said vane means, wherein said force transmitting means includes latching means connected thereto and operative to latch said vane means in its coupling position throughout the movement of said doors from said open to said closed positions.

2. An apparatus as claimed in claim 1, wherein said latching means includes first and second latching link members, said latching link members being interconnected so as to form a broken-arm type of latching device.

3. An apparatus as claimed in claim 2, wherein said apparatus includes releasing means mounted on said elevator car and disposed in the path of travel of said latching link members, said releasing means being operative to engage said latching link members when said car door is in said closed position for unlatching said vane means in said closed position.

4. An apparatus as claimed in claim 3, wherein said force transmitting means also includes a drive link member pivotally connected at one end thereof to said door operating means, and said force transmitting means includes a guide link member pivotally connected to said drive link member for supporting and guiding said drive link member.

5. An apparatus as claimed in claim 4, wherein said interlock means includes roller means, and wherein said vane means includes a pair of elongate vane members for clamping said roller means therebetween, said vane means having a pair of pivot arms, said pivot arms having respective end pivots pivotally connected to said vane members, and said pivot arms having respective center pivots pivotally connected to said car door.

6. An apparatus as claimed in claim 5, wherein said door operating means has an elongate crank arm, said crank arm having an axis of rotation at one end thereof about which said crank arm is rotatable, said crank arm being connected at the other end thereof to said drive link.

7. An apparatus as claimed in claim 6, wherein said drive link has a first pivot shaft at one end thereof connected to said guide link and has a second pivot shaft at the other end thereof connected to said door operating means, and wherein said guide link has a pivot shaft at one end thereof connected to said elevator car door, and wherein said first latching link has a first pivot shaft at one end thereof connected to said second latching link and has a second pivot shaft at the other end thereof connected to said vane means.

8. The apparatus as claimed in claim 7, wherein said drive link has a lever portion projecting therefrom, said lever portion being rotatable about said first pivot shaft of said drive link for transmitting said operating force from said drive link to said vane means.

9. The apparatus as claimed in claim 8, wherein said second latching link has a trip portion projecting therefrom, said trip portion being rotatable about said first pivot shaft of said drive link, said trip portion being arranged to engage said releasing means when the car door is in the closed position for unlatching said vane means.

10. An apparatus as claimed in claim 9, wherein said pivot shafts of said drive link and guide link and latching links are substantially parallel to each other and to said axis of rotation of said crank arm.

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11. The apparatus as claimed in claim 10, wherein said vane means has elongate spring means, said spring means being connected at one end thereof to said vane means and being connected at the other end thereof to said drive link for urging said pair of vanes away from said roller means.

12. The apparatus as claimed in claim 11, wherein said latching links have elongate spring means, said spring means being connected at one end thereof to said second latching link and being connected at the other end thereof to said vane means for urging said latching links into a substantially aligned position for latching said vane means.

13. A door coupling apparatus for coupling a door of the elevator car to a door of the hoistway in an elevator system for simultaneous displacement of said doors throughout their movement between opened and closed positions comprising,

door operating means mounted on said elevator car for moving said doors in both the opening and closing direction,

a pair of vanes mounted on said car door and a roller mounted on said hoistway door, said vanes being movable relative to said car door between coupling and uncoupling conditions, said roller and said vanes cooperating when said vanes are in said coupling condition to couple said hoistway door to said car door, and

linkage means connected at one end thereof to said door operating means and connected at the other end thereof to said pair of vanes for transmitting an operating force therethrough, wherein

said linkage means includes latching means connected thereto and to said pair of vanes and operative to latch said pair of vanes when said pair of vanes couple said hoistway door to said car door so that said pair of vanes is maintained in said coupling condition throughout the movement of said hoistway door in the closing direction to its closed position.

14. An apparatus as claimed in claim 13, wherein said door operating means includes a drive motor and a crank arm, said crank arm being connected to said drive motor at one end thereof for rotation about an axis of rotation of said motor and being connected at the other end thereof to said linkage means, and wherein

said apparatus includes interlock means, said interlock means having an interlock lever pivotally mounted on said hoistway door and a housing mounted in said hoistway for receiving said lever, said lever having a latch surface, said housing having a catch surface for cooperating with said latch surface to lock said hoistway door in said closed position, said latch surface and said catch surface being separable by an interlock clearance forming an interlock zone when said hoistway door is locked, and wherein

said interlock lever has said roller mounted thereon whereby said vanes in cooperating with said roller to uncouple and couple said doors pivots said lever to move said latch surface into and out of its cooperating relationship with said catch surface, respectively, and wherein

said pair of vanes have a pair of pivot arms, said pivot arms having respective end pivots pivotally connected to said vanes and having respective center pivots pivotally connected to said car door, and wherein

said apparatus includes releasing means, said releasing means being operative to coast with said latching means to unlatch said pair of vanes when said hoistway door is in said closed position and said lever is in position to pivot said latch surface into its cooperating relationship with said catch surface and lock said door.

15. An apparatus as claimed in claim 14, wherein said latching means includes a pair of pivotally connected latching links for latching said vanes, and wherein

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said linkage means includes a drive link and a guide link pivotally connected to said latching links for transmitting said operating force to said pair of vanes and for actuating said latching links, said drive link having a lever portion for actuating said vanes, said guide link being angularly displaceable relative to said drive link and latching links for guiding said drive link and for actuating said latching links, and wherein

said releasing means includes a releasing cam for engaging said latching links for unlatching said vanes, and wherein

said latching links have a trip portion, said trip portion and said releasing cam being arranged to coast when said hoistway door is in said closed position for tripping said latching links for unlatching said vanes, and wherein

said latching links have an elongate spring means, said latch spring means being connected at one end thereof to said latching links and being connected at the other end thereof to said vane means, and wherein said vanes have an elongate spring means, said vane spring means being connected at one end thereof to said vanes and being connected at the other end thereof to said drive link, and wherein

said latching links and drive link and guide link and crank arm are interconnected by pivot shafts, said pivot shafts being substantially parallel to each other and to said crank arm axis.

16. A door coupling apparatus for an elevator system for coupling the door of an elevator car to a hoistway door comprising, door operating means mounted on said elevator car for moving said doors between opened and fully closed positions, interlock means mounted on said hoistway door for locking said hoistway door in its fully closed position, said interlock means including an unlocking roller, vane means pivotally mounted on said car door and movable relative thereto between coupling and uncoupling positions, said vane means being operable in its coupling position to engage said unlocking roller for unlocking said hoistway door and for coupling said hoistway door to said car door for displacement of said doors between said opened and fully closed positions, said vane means providing clearance between itself and said unlocking roller in said uncoupling position, and an elongate force transmitting means connected at one end thereof to said door operating means and at the other end to said vane means for transmitting an operating force from said door operating means to said vane means, wherein the improvement comprises latching means connected to said vane means and operative to maintain said vane means in said coupling position throughout the movement of said doors from their opened to their fully closed positions, said latching means including first and second interconnected latching link members forming a broken-arm type of latching device, and releasing means mounted on said elevator car in the path of travel of said latching link members for engagement with said members after said doors reach their fully closed positions to release the latch provided for said vane means by said members thereby enabling said vane means to operate to said uncoupling position.

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