DOOR ASSEMBLY

Field of the Invention

The present invention relates, in general, to door systems and more particularly to a door assembly.

Background of the Invention

Double leaf doors are particularly suitable for large openings as such doors can be made to span a large opening. However, double leaf doors typically require two hands to operate. Consequently, it may be inconvenient to open or close a double leaf door with only one hand.

Summary of the Invention

Accordingly, in a first aspect, the present invention provides a door assembly including a rail assembly, a first panel, a first arm, a second panel, a second arm and a connector mechanism. The rail assembly includes a first rail and a second rail coupled to the first rail. A first end of the first arm is rotatably attached to the first panel and a second end of the first arm is in slidable engagement with the first rail; a first end of the second arm is rotatably attached to the second panel and a second end of the second arm is in slidable engagement with the second rail. The connector mechanism connects the second end of the first arm to the second end of the second arm and is configured to move the second end of the first arm and the second end of the second arm in opposite directions.

Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

Brief Description of the Drawings

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

FIG. 1A is a schematic front view of a door assembly in accordance with an embodiment of the present invention;

FIG. 1B is a schematic rear view of the door assembly of FIG. 1A;

FIG. 1C is a schematic top plan view of the door assembly of FIG. 1A in an open position;

FIG. 1D is a schematic top plan view of the door assembly of FIG. 1A in a closed position;

FIG. 1E is a schematic vertical sectional view of the door assembly of FIG. 1A;

FIG. 1F is a schematic diagram illustrating a connector mechanism of the door assembly of FIG. 1A;

FIG. 1G is a schematic exploded view of a roller of the connector mechanism of FIG. 1F;

FIG. 2A is a schematic front view of a door assembly in accordance with another embodiment of the present invention;

FIG. 2B is a schematic rear view of the door assembly of FIG. 2A;

FIG. 2C is a schematic top plan view of the door assembly of FIG. 2A in a half-open position;

FIG. 2D is a schematic top plan view of the door assembly of FIG. 2A in a partially open position;

FIG. 2E is a schematic diagram illustrating a connector mechanism of the door assembly of FIG. 2A;

FIG. 2F is a schematic exploded view of a roller of the connector mechanism of FIG. 2E;

FIG. 3A is a schematic diagram illustrating another connector mechanism for the door assembly of FIG. 2A;

FIG. 3B is a schematic exploded view of a roller of the connector mechanism of FIG. 3A.

FIG. 4A is a schematic front view of a door assembly in accordance with yet another embodiment of the present invention;

FIG. 4B is a schematic rear view of the door assembly of FIG. 4A;

FIG. 4C is a schematic top plan view of the door assembly of FIG. 4A in a partially open position;

FIG. 4D is a schematic diagram illustrating a stopper mechanism of the door assembly of FIG. 4A; and

FIG. 4E is a schematic diagram illustrating a locking mechanism of the door assembly of FIG. 4A.

Detailed Description of Exemplary Embodiments

The following detailed description of preferred embodiments of the invention will be better understood when read in conjunction with the appended drawings. The present invention is illustrated by way of example and is not limited by the accompanying figures, in which like references indicate similar elements. It is to be understood that the drawings are not to scale and have been simplified for ease of understanding the invention. It is to be understood that the same or equivalent functions may be accomplished by different embodiments that are intended to be encompassed within the scope of the invention.

Referring now to FIGS. 1A through 1G, a door assembly 10 is shown. The door assembly 10 includes a rail assembly 12, a first panel 14, a first arm 16, a second panel 18, a second arm 20 and a connector mechanism 22. The rail assembly 12 includes a first rail 24 and a second rail 26 coupled to the first rail 24. A first end 16a of the first arm 16 is rotatably attached to the first panel 14 and a second end 16b of the first arm 16 is in slidable engagement with the first rail 24; a first end 20a of the second arm 20 is rotatably attached to the second panel 18 and a second end 20b of the second arm 20 is in slidable engagement with the second rail 26. The connector mechanism 22 connects the second end 16b of the first arm 16 to the second end 20b

of the second arm 20 and is configured or operable to move or draw the second end 16b of the first arm 16 and the second end 20b of the second arm 20 in opposite directions.

Advantageously, because the second ends 16b and 20b of the first and second arms 16 and 20 are connectedly drawn or moved in opposite directions by the connector mechanism 22 when in use, both the first and second panels 14 and 18 of the door assembly 10 may be simultaneously opened or closed by just activating one of the first and second panels 14 and 18. This facilitates operation of the door assembly 10 with only one hand. For example, to open the door assembly 10 shown in FIG. 1A, a user (not shown) only needs to pull a handle 14a attached to the first panel 14 towards the user and this causes the second end 16b of the first arm 16 to slide along the first rail 24 towards a hinged end of the first panel 14. As this happens, the connector mechanism 22 connecting the second end 16b of the first arm 16 to the second end 20b of the second arm 20 simultaneously draws the second end 20b of the second arm 20 towards a hinged end of the second panel 18, forcing the second panel 18 of the door assembly to open outwards at the same time. Conversely, when the first panel 14 of the door assembly 10 is moved into a closed position, the second end 16b of the first arm 16 slides along the first rail 24 away from the hinged end of the first panel 1412 and the connector mechanism 22 simultaneously draws the second end 20b of the second arm 20 away from a hinged end of the second panel 18, forcing the second panel 18 of the door assembly to close inwards as well.

The first panel 14 may be hinged to a first jamb 28a and the second panel 18 may be hinged to a second jamb 28b.

The first and second rails 24 and 26 may be in a stacked arrangement as shown in FIG. 1E. Advantageously, this compact arrangement helps reduce installation space required for the door assembly 10. In the embodiment shown, the first and second rails 24 and 26 in the stacked arrangement are in a back-to-back orientation.

In an alternative embodiment, the first and second rails 24 and 26 may be in a lateral or side-by-side arrangement. Advantageously, the lateral or side-by-side arrangement facilitates installation and/or maintenance of the rail assembly 12,

particularly in implementations where the rail assembly 12 is some distance from ground.

As shown in FIGS. 1B and 1E through 1G, the connector mechanism 22 may include a connector 30 connecting the second end 16b of the first arm 16 to the second end 20b of the second arm 20 and a plurality of rollers 32 attached to the rail assembly 12, the rollers 32 being operable to move or rotate the connector 30. In the embodiment shown, the connector 30 may be a string or a wire. In the same or alternative embodiments, each of the rollers 32 may be a sheave to receive the string or the wire.

As can be seen from FIG. 1C, the first arm 16 may be longer than the second arm 20. Advantageously, a longer leading arm 16 increases mechanical advantage and reduces effort required, making it easier to operate the door assembly 10. First and second arms 16 and 20 of different lengths may also advantageously be used to accommodate first and second panels 14 and 18 of different sizes and/or widths.

As can be seen from FIG. 1E, a width of the first arm 16 may be narrower than a width of the second arm 20.

Referring now to FIGS. 2A through 2F, a door assembly 50 in accordance with another embodiment is shown. The door assembly 50 of the present embodiment differs from the earlier embodiment in that the door assembly 50 further includes a first extender 52 slidably received in the first rail 24, the first extender 52 connecting the second end 16b of the first arm 16 to the connector mechanism 22, and a second extender 54 slidably received in the second rail 26, the second extender 54 connecting the second end 20b of the second arm 20 to the connector mechanism 22. Advantageously, provision of the first and second extenders 52 and 54 allows attachment points where the first and second arms 16 and 20 engage the rail assembly 12 to be closer to one another, facilitating control of the door assembly 50. Further advantageously, provision of the first and second extenders 52 and 54 also allows use of shorter and/or balanced first and second arms 16 and 20 of the same length, providing better control of the door assembly 50 and improving manufacturing and operational tolerance.

As can be seen from FIGS. 2C and 2D, the door assembly 50 of the present embodiment also differs from the earlier embodiment in that the door assembly 50 further includes a first spacer 56 extending between the rail assembly 12 and the connector 30 and a second spacer 58 extending between the rail assembly 12 and the connector 30. The first spacer 56 is coupled to a first point along the connector 30 and the second spacer 58 is coupled to a second point along the connector 30. Advantageously, the first and second spacers 56 and 58 help to bridge movement of the first and second arms 16 and 20 in a horizontal plane with movement or rotation of the connector 30 in a vertical plane, allowing smooth operation of the connector mechanism 22 without interference from movement of the first and second arms 16 and 20.

The door assembly 50 of the present embodiment further differs from the earlier embodiment in that the door assembly 50 further includes a protrusion 60 extending along a distal edge of the first panel 14, and a groove 62 extending along a corresponding distal edge of the second panel 18, the protrusion 60 being arranged to be interlocked with the groove 62 when the first and second panels 14 and 18 are in a closed position. Advantageously, provision of the protrusion 60 and the groove 62 at the distal edges of the first and second panels 14 and 18 helps facilitate secure closure of the door assembly 50 by locking the first and second panels 14 and 18 in place when the door assembly 50 is in the closed position. The interlocking protrusion 60 and groove 62 also help facilitate alignment of the first and second panels 14 and 18, reducing a gap between the first and second panels 14 and 18. Further advantageously, the protrusion 60 also helps trigger or initiate opening of the door assembly 50 when either one of the first and second panels 14 and 18 is pulled outwards.

As shown in FIGS. 2E and 2F, the door assembly 50 of the present embodiment may also differ from the earlier embodiment in that the connector 30 of the connector mechanism 22 may be a ball chain. In the same or alternative embodiments, each of the rollers 32 of the connector mechanism 22 may be a sprocket to receive the ball chain.

Referring now to FIGS. 3A and 3B, a connector mechanism 90 in accordance with yet another embodiment is shown. In the embodiment shown, the connector 92 of

the connector mechanism 90 may be a toothed belt. In the same or alternative embodiments, each of the rollers 94 of the connector mechanism 90 may be a sprocket to receive the toothed belt.

Advantageously, use of the ball chain or the toothed belt with the sprocket allows more precise control of the connector mechanism 22 or 90 as adjustments or movements of the connector 30 or 92 may be timed or stepped in such implementations. Further advantageously, because balls of the ball chain or teeth of the toothed belt are received in corresponding notches or teeth of the sprocket, engagement of the connector 30 or 92 to the rollers 32 or 94 is secure, preventing disengagement of the connector 30 or 92 from the rollers 32 or 94 or slipping of the connector 30 or 92 from the rollers 32 or 94 in use.

Referring now to FIGS. 4A through 4E, a door assembly 100 in accordance with yet another embodiment is shown. The door assembly 100 of the present embodiment differs from the earlier embodiments in that the first and second rails 24 and 26 of the rail assembly 12 of the door assembly 100 in the stacked arrangement are in a face-to-face orientation. Advantageously, the face-to-face orientation of the first and second rails 24 and 26 reduces a separation between the first and second arms 16 and 20, resulting in a more compact arrangement of the rail assembly 12, thereby improving aesthetic appeal of the door assembly 100.

As can be seen from FIG. 4B, the door assembly 100 of the present embodiment may also differ from the earlier embodiments in that the door assembly 100 further includes a stopper mechanism 102 attached to the first and second panels 14 and 18, the stopper mechanism 102 being configured to lock the first and second panels 14 and 18 in place when in a closed position.

As can be seen from FIG. 4D, the stopper mechanism 102 may include a slot 104 attached to one of the first and second panels 14 and 18, and a stopper 106 received in the slot 104 and moveable between a retracted position and an extended position. An activator 108 may be attached to a corresponding one of the first and second panels 14 and 18, the activator 108 being operable to push the stopper 106 into the extended position. In the retracted position, the stopper 106 rests on an upper edge of the one of the first and second panels 14 and 18 to which the slot 104 is

attached. As the door assembly 100 is being closed, the activator 108 protruding from the corresponding one of the first and second panels 14 and 18 is received in a gap between the stopper 106 and the upper edge of the one of the first and second panels 14 and 18 to which the slot 104 is attached and lifts the stopper 106 out from the slot 104 into the extended position where the stopper 106 comes into contact with the rail assembly 12 and secures the first and second panels 14 and 18 to the rail assembly 12. In this manner, the stopper mechanism 102 helps lock the first and second panels 14 and 18 more securely when closed. The stopper 106 may include a chamfered edge to receive the activator 108. Advantageously, with the chamfered edge, the activator 108 may be more readily received in the gap between the stopper 106 and the upper edge of the one of the first and second panels 14 and 18 to which the slot 104 is attached.

Timing of closure of the first and second panels 14 and 18 may be controlled by adjusting relative tautness of respective sections of the connector 30 driving movement of the first and second arms 16 and 20. For example, a first length of the connector 30 between the first and second points and passing over a first distal roller 32 may be shorter than a second length of the connector 30 between the first and second points and passing over a second distal roller 32 at an opposing end to the first distal roller 32. In such an arrangement, one of the first and second panels 14 and 18 precedes the other into the closed position, allowing the preceding panel 14 or 18 with the slot 104 and the stopper 106 attached to be in place before the following panel 14 or 18 with the activator 108 attached moves into place and activates the stopper mechanism 102 to securely lock the first and second panels 14 and 18 in the closed position. To facilitate adjustment of the relative tautness of the respective sections of the connector 30, at least one of the first and second spacers 56 and 58 may include a catch 110 configured to engage the connector 30. This may, for example, allow adjustment of the relative tautness of the respective sections of the connector 30 by shifting the balls of the ball chain relative to the catch 110. A separation between the first and second distal rollers 32 may be adjusted to either bring the first or second distal roller 32 nearer to or further away from one another.

As shown in FIGS. 4A, 4B and 4E, the door assembly 100 may include a locking mechanism 112 received in one of the first and second panels 14 and 18. The locking mechanism 112 may include a retractable catch 114 actuable by a release

mechanism 116. The locking mechanism 112 automatically locks the door assembly 100 when the first and second panels 14 and 18 are in the closed position. The door assembly 100 is unlocked when the retractable catch 114 is released by the release mechanism 116 which may be operated with one hand. Advantageously, the locking mechanism 112 provides more secure and sturdy locking of the door assembly 100.

A motor 118 may be attached to the connector 30, the motor 118 being operable to drive movement of the connector 30. Advantageously, the motor 118 takes over some of the work required to move the connector 30 and also helps to control and automate movement of the connector 30. This helps further reduce the effort required to operate the door assembly 100. The motor 118 may be received in one of the first and second door jambs 28a and 28b.

As is evident from the foregoing discussion, the present invention provides a double leaf door assembly that may be easily opened or closed with only one hand.

While preferred embodiments of the invention have been illustrated and described, it will be clear that the invention is not limited to these embodiments only. Numerous modifications, changes, variations, substitutions and equivalents will be apparent to those skilled in the art without departing from the scope of the invention as described in the claims.

Further, unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising" and the like are to be construed in an inclusive as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

CLAIMS

1. A door assembly, comprising:

a rail assembly, comprising:

a first rail, and

a second rail coupled to the first rail;

a first panel;

a first arm having a first end rotatably attached to the first panel and a second end in slidable engagement with the first rail;

a second panel;

a second arm having a first end rotatably attached to the second panel and a second end in slidable engagement with the second rail; and

a connector mechanism connecting the second end of the first arm to the second end of the second arm, wherein the connector mechanism is configured to move the second end of the first arm and the second end of the second arm in opposite directions.

2. The door assembly of claim 1, wherein the connector mechanism comprises:

a connector connecting the second end of the first arm to the second end of the second arm; and

a plurality of rollers attached to the rail assembly, wherein the rollers are operable to move the connector.

3. The door assembly of claim 2, wherein the connector is selected from a group consisting of a string, a wire, a toothed belt and a ball chain.

4. The door assembly of claim 3, wherein each of the rollers is a sheave to receive the string or the wire, or a sprocket to receive the toothed belt or the ball chain.

5. The door assembly of any one of claims 2 to 4, further comprising:

a first spacer extending between the rail assembly and the connector, wherein the first spacer is coupled to a first point along the connector; and

a second spacer extending between the rail assembly and the connector, wherein the second spacer is coupled to a second point along the connector.

6. The door assembly of claim 5, wherein a first length of the connector between the first and second points and passing over a first distal roller is shorter than a second length of the connector between the first and second points and passing over a second distal roller at an opposing end to the first distal roller.

7. The door assembly of claim 5 or 6, wherein at least one of the first and second spacers comprises a catch configured to engage the connector.

8. The door assembly of any one of claims 2 to 7, further comprising a motor attached to the connector, wherein the motor is operable to drive movement of the connector.

9. The door assembly of any one of the preceding claims, wherein the first arm is longer than the second arm.

10. The door assembly of any one of the preceding claims, wherein a width of the first arm is narrower than a width of the second arm.

11. The door assembly of any one of preceding claims, further comprising:

a first extender slidably received in the first rail, the first extender connecting the second end of the first arm to the connector mechanism; and

a second extender slidably received in the second rail, the second extender connecting the second end of the second arm to the connector mechanism.

12. The door assembly of any one of the preceding claims, wherein the first and second rails are in a stacked arrangement or lateral arrangement.

13. The door assembly of claim 12, wherein the first and second rails in the stacked arrangement are in a face-to-face orientation or a back-to-back orientation.

14. The door assembly of any one of the preceding claims, further comprising:

a protrusion extending along a distal edge of the first panel; and

a groove extending along a corresponding distal edge of the second panel, wherein the protrusion is arranged to be interlocked with the groove when the first and second panels are in a closed position.

15. The door assembly of any one of the preceding claims, further comprising:

a stopper mechanism attached to the first and second panels, wherein the stopper mechanism is configured to lock the first and second panels in place when in a closed position.

16. The door assembly of claim 15, wherein the stopper mechanism comprises:

a slot attached to one of the first and second panels;

a stopper received in the slot and moveable between a retracted position and an extended position.

17. The door assembly of claim 16, further comprising:

an activator attached to a corresponding one of the first and second panels, wherein the activator is operable to push the stopper into the extended position.

18. The door assembly of claim 17, wherein the stopper comprises a chamfered edge to receive the activator.

19. The door assembly of any one of the preceding claims, further comprising:

a locking mechanism received in one of the first and second panels, wherein the locking mechanism comprises a retractable catch actuable by a release mechanism.