

## HINGE DEVICE FOR A FOLDING DOOR

### BACKGROUND OF THE INVENTION

The present invention relates to a hinge device and, more particularly, to a hinge device for a folding door.

5           A type of conventional folding door used in such as an airplane lavatory includes two door panels connected by a hinge. A hinge for a folding door of a lavatory used in Boeing commercial airliners includes two hinge members and a connection member. Each hinge member is coupled with an inner end of one of the door panels and includes a gear portion. Two ends of the connection member are pivotally coupled with  
10   the gear portions of the hinge members, respectively. The gear portions of the hinge members mesh with each other, allowing the door panels to be folded or unfolded for opening or closing purposes.

However, the conventional folding door has the following disadvantages in use:

(1) When the folding door is mounted at a site (e.g. a bathroom) and is in a  
15   closed state, the two hinge members face the inside of the bathroom, and the connection member faces the outside of the bathroom. Thus, the gear portions of the hinge members rust easily because the gear portions are liable to be splashed by water inside the bathroom when the folding door is unfolded, reducing the smoothness of the pivotal movement of the door panels.

20           (2) After the folding door is mounted at the site (e.g. a bathroom), screws for fixing the hinge members to the door panels are exposed and, thus, adversely affect the aesthetical appearance and rust easily.

(3) When the folding door is in the closed state, the connection member is exposed outside the folding door and is, thus, vulnerable to destruction.

(4) A large gap exists between the door panels when the folding door is in the closed state, and the hinge members engage with each other by the gear portions only, failing to reliably secure the door panels together.

5 (5) Each hinge member has a column that deforms easily under impact from an external force applied improperly. This damages the meshing between the gear portions and adversely affects the smoothness of folding and unfolding operations of the door panels.

Thus, a need exists for a novel hinge device for effectively securing door panels of a folding door together in the closed state and enhancing the smoothness of folding  
10 and unfolding operations of the door panels.

#### BRIEF SUMMARY OF THE INVENTION

The present invention solves this need and other problems by providing a hinge device adapted for connecting inner ends of two door panels of a folding door to allow the door panels to pivot synchronously upon movement of one of the door panels. The  
15 hinge device includes two installation strips and a connection strip. Each installation strip extends in a longitudinal direction and includes first and second side walls spaced from each other in a thickness direction perpendicular to the longitudinal direction and a connection wall connected between the first and second side walls. Each of the first and second side walls includes inner and outer ends spaced in a width direction  
20 perpendicular to the longitudinal and thickness directions. The outer ends of the first and second side walls respectively protrude from the connection walls and away from the inner ends of the first and second side walls in the width direction. An installation slot is defined between the outer ends of the first and second side walls and adapted for receiving the inner end of an associated door panel. Each installation strip includes a  
25 toothed portion extending from the inner end of the second side wall thereof toward but spaced from the first side wall thereof. Each toothed portion includes a plurality of teeth

formed on an outer face thereof, and the toothed portions of the installation strips mesh with each other, allowing the door panels to pivot synchronously upon movement of one of the door panels. The connection strip extends in the longitudinal direction and includes a cover portion and two shaft arms located in the cover portion and spaced from each other. Each shaft arm includes an outer end connected to the cover portion and an inner end forming a shaft portion. The shaft portion of each shaft arm is engaged in the toothed portion of one of the installation strips. The installation strips can be pivoted synchronously relative to the connection strip between a first position and a second position, with the shaft portions serving as pivots. When the installation strips are in the first position, the door panels are unfolded, and the connection strip is located in the installation strips. When the installation strips are in the second position, the door panels are folded, and the cover portion of the connection strip is partially located outside of the installation strips.

In examples, each installation strip further includes an extension extending from the inner end of the first side wall thereof toward but spaced from the second side wall thereof. The extension of each installation strip includes a distal end, and the toothed portion and the distal end of the extension are spaced from each other and define an opening therebetween. When the installation strips are in the first position, the extensions of the installation strips abut with each other, and the distal ends of the extensions are located at a middle of the cover portion of the connection strip. When the installation strips are in the second position, the cover portion of the connection strip is located between the distal ends of the extensions of the installation strips.

In examples, each installation strip further includes a shield extending from the inner end of the second side wall thereof toward but spaced from the connection wall thereof. A coupling slot is defined by the shield and an inner face of an associated

toothed portion and is substantially semi-circular in cross section. Each shaft portion of the connection strip is engaged in the coupling slot of one of the installation strips.

In examples, each installation strip includes an upper section, a lower section, and an intermediate section between the upper and lower sections. The toothed portion of each installation strip includes a plurality of teeth formed on an outer face thereof. A number of the teeth of the toothed portion at the intermediate section of each installation strip are less than a number of the teeth of the toothed portion at each of the upper and lower sections.

The present invention will become clearer in light of the following detailed description of illustrative embodiments of this invention described in connection with the drawings.

#### DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an exploded, perspective view of a hinge device of a first embodiment according to the present invention, with two door panels connected by the hinge device to form a folding door.

FIG. 2 is a partial, enlarged view of the folding door of FIG. 1.

FIG. 3 is a schematic elevational view of the folding door of FIG. 1 mounted at a site.

FIG. 4 is an assembled, perspective view of the folding door of FIG. 1.

FIG. 5 is a cross sectional view taken along line 5-5 in FIG. 3.

FIG. 6 shows a view similar to FIG. 5, with two installation strips of the hinge device pivoted relative to a connection strip of the hinge device.

FIG. 7 shows a view similar to FIG. 5, with the door panels folded from a closed state to an open state.

FIG. 8 is a cross sectional view taken along line 8-8 in FIG. 3.

FIG. 9 shows a partial, sectional view of a bottom portion of the folding door of FIG. 1.

FIG. 10 is a schematic, cross sectional view of a hinge device of a second embodiment according to the present invention.

5        FIG. 11 shows a view similar to FIG. 10, with the door panels folded from a closed state to an open state.

FIG. 12 is a schematic, cross sectional view of a hinge device of a third embodiment according to the present invention.

10       FIG. 13 shows a view similar to FIG. 12, with the door panels folded from a closed state to an open state.

FIG. 14 is a schematic view of a hinge device of a fourth embodiment according to the present invention, with two thin door panels connected by the hinge device to form a folding door.

#### DETAILED DESCRIPTION OF THE INVENTION

15        A hinge device of a first embodiment according to the present invention is shown in FIGS. 1 through 9 of the drawings and generally designated 10. Hinge device 10 is adapted for connecting two door panels 12 to form a folding door 14. Folding door 14 can be mounted at a site, such as an airplane lavatory, telephone box, home bathroom, etc., for partitioning purposes. Referring to FIG. 3, a guide roller 16 is mounted on a top  
20 of one of door panels 12 of folding door 14, and a shaft 17 is disposed on an upper end of the other door panel 12 and is pivotally mounted to an upper frame strip 18 of an installation interface of the site. Guide roller 16 is slidably mounted in the upper frame strip 18 to allow door panels 12 to pivot relative to each other. Each door panel 12 includes an inner surface 20, an outer surface 22 opposite to inner surface 20, and an  
25 inner end 24. When folding door 14 is mounted at the site (e.g. a bathroom) and is in a closed state (see FIGS. 3 and 5), inner surfaces 20 of door panels 12 face an inside of the

bathroom, and outer surfaces 22 of door panels 12 face an outside of the bathroom. Furthermore, inner ends 24 of door panels 12 face each other.

Hinge device 10 includes two installation strips 26 and a connection strip 28 connecting installation strips 26. Each installation strip 26 is in the form of a frame and includes an upper section 30, a lower section 32, and an intermediate section 34 between upper and lower sections 30 and 32. In this embodiment, upper section 30, lower section 32, and intermediate section 34 of each installation strip 26 are separate components. However, upper section 30, lower section 32, and intermediate section 34 of each installation strip 26 can be integrally formed as a one-piece component.

In this embodiment, each installation strip 26 extends in a longitudinal direction and includes a first side wall 36, a second side wall 37 spaced from first side wall 36 in a thickness direction perpendicular to the longitudinal direction, and a connection wall 38 connected between first and second side walls 36 and 37. Each of first and second side walls 36 and 37 includes inner and outer ends 40 and 42 spaced in a width direction perpendicular to the longitudinal and thickness directions. Outer ends 42 of first and second side walls 36 and 37 protrude from connection wall 38 and away from inner ends 40 in the width direction, such that an installation slot 44 is defined between outer ends 42 of first and second side walls 36 and 37 for receiving inner end 24 of an associated door panel 12. In this embodiment, each installation strip 26 is fixed on inner end 24 of the associated door panel 12 by screws 45 extending through holes 47 in connection wall 38 (see FIG. 5).

An extension 46 extends from inner end 40 of first side wall 36 of each installation strip 26 toward but spaced from second side wall 37 in the thickness direction and includes a distal end 48 having a lip. A toothed portion 50 extends from inner end 40 of second side wall 37 of each installation strip 26 toward but spaced from first side wall 36. Each toothed portion 50 is arcuate and includes a plurality of teeth 51

formed on an outer face thereof, and toothed portions 50 of installation strips 26 mesh with each other. In this embodiment, a shield 52 extends from inner end 40 of second side wall 37 of each installation strip 26 toward but spaced from connection wall 38. A coupling slot 54 is defined by each shield 52 and an inner face of an associated toothed portion 50 and is substantially semi-circular in cross section. Toothed portion 50 and distal end 48 of extension 46 of each installation strip 26 are spaced from each other in the thickness direction and define an opening 56 therebetween. Opening 56 is in communication with an interior space 58 of a corresponding installation strip 26. Preferably, each opening 56 has a size large enough for screws 45 and a hand tool (e.g. a screwdriver) to pass therethrough, allowing convenient operation of the hand tool to fix installation strips 26 to inner ends 24 of door panels 12 by screws 45.

Connection strip 28 extends in the longitudinal direction and includes two shaft arms 60 spaced from each other. A shaft portion 62 is formed on an inner end of each shaft arm 60 and has an outer diameter slightly smaller than an inner diameter of coupling slot 54 of an associated installation strip 26. A spacing between centers of shaft portions 62 of connection strip 28 is slightly smaller than a spacing between centers of toothed portions 50 of installation strips 26. Thus, when shaft portions 62 of connection strip 28 are respectively received in coupling slots 54 of installation strips 26, an outer surface of each shaft portion 62 will not be in contact with the entire inner face of an associated toothed portion 50, reducing the friction generated during pivotal movement of installation strips 26. Furthermore, a length of each shaft arm 60 of connection strip 28 is slightly smaller than a spacing between the center of toothed portion 50 and connection wall 38 of each installation strip 26. The length of each shaft arm 60 is determined according to the size of opening 56 of each installation strip 26.

The connection strip 28 further includes a substantially C-shaped cover portion 64 connected to outer ends of shaft arms 60. In this embodiment, a recessed portion 66 is

formed in a middle of cover portion 64 and extends in the longitudinal direction. More specifically, cover portion 64 includes two arc-shaped sections 69 each having first and second ends. Each arc-shaped section 69 is connected to the outer end of a corresponding shaft arm 60 and has a center located in one of shaft portions 62 or one of coupling slots 54 (see FIG. 5). The first ends of arc-shaped sections 69 are connected with each other and meet at the middle of cover portion 64 to form recessed portion 66. Further, each end 67 of cover portion 64 (the second end of each arc-shaped section 69) protrudes beyond shaft arms 60, with shaft arms 60 located between ends 67 of cover portion 64. A length of each end 67 protruding beyond shaft arm 60 corresponds to a length of shield 52 of an associated installation strip 26, such that ends 67 can be close to second side walls 37 and such that each shaft portion 62 of connection strip 28 can securely be coupled in an associated coupling slot 54. Therefore, connection strip 28 and installation strips 26 can withstand impact exerted on inner surfaces 20 or outer surfaces 22 of door panels 12.

In an example of assembling hinge device 10, second side walls 37 of installation strips 26 abut with each other, with toothed portions 50 meshed with each other (see FIG. 7). Then, connection strip 28 is inserted through openings 56 into installation strips 26 in the longitudinal direction, with each shaft portion 62 of connection strip 28 received in coupling slot 54 of an associated installation strip 26. Thus, installation strips 26 (including upper and lower sections 30 and 32 and intermediate section 34) are connected by connection strip 28 and can pivot synchronously relative to the connection strip 28 between a first position and a second position, with shaft portions 62 serving as pivots. When installation strips 26 are in the first position (inner ends 40 located between outer ends 42, see FIG. 5), door panels 12 are unfolded and aligned end to end to form a rectilinear structure, folding door 14 is in a closed state, and connection strip 28 is covered by installation strips 26. On the other

hand, when installation strips 26 are in the second position (see FIG. 7), door panels 12 are folded and abut with each other side by side, folding door 14 is in an open state, and cover portion 64 of connection strip 28 is located outside of installation strips 26. Preferably, the length of shield 52 of each installation strip 26 in the thickness direction extends beyond a center of an associated coupling slot 54, such that the center of coupling slot 54 of each installation strip 26 is located between a distal end of a corresponding shield 52 and second side wall 37 in the thickness direction (FIG. 7). Thus, in the open state shown in FIG. 7, when a longitudinal external force is applied to connection strip 28, shields 52 of installation strips 26 can effectively withstand the external force and can prevent shaft portions 62 from disengaging from coupling slots 54.

In use, when door panels 12 is in the closed state (FIG. 5), connection strip 28 is concealed in installation strips 26, and toothed portions 50 of installation strips 26 are located on a side of outer surfaces 22 of door panels 12. Thus, connection strip 28 can be protected effectively from damage, and toothed portions 50 can be prevented from being splashed by water. Furthermore, in the closed state, distal ends 48 of extensions 46 installation strips 26 are received in recessed portion 66 of cover portion 64, and extensions 46 abut with each other, such that only a small gap or no gap exists between door panels 12 to enhance the privacy, and door panels 12 can securely be connected together

In addition, when door panels 12 are in the open state shown in FIG. 7, distal end 48 of extension 46 of each installation strip 26 is located near or abuts an outer surface of cover portion 64, and toothed portions 50 of installation strips 26 reliably mesh with each other for maintaining connection of door panels 12. Furthermore, shaft portions 62 of connection strip 28 are securely coupled in coupling slots 54 to allow smooth pivotal movement of door panels 12. Referring to FIGS. 5 to 7, the center of

coupling slot 54 of each installation strip 26 is not concentric to the center of an associated shaft portion 62, such that the contact surface between each installation strip 26 and the corresponding shaft portion 62 is the smallest regardless of the angle between door panels 12 when door panels 12 are pivoted, achieving the purposes of smooth pivotal movement.

Referring to FIG. 8, toothed portion 50 of intermediate section 34 of each installation strip 26 can include fewer teeth 51, such as one or two teeth 51. With this arrangement, when a user presses hinge device 10 by a hand to open or close door panels 12, the hand touching toothed portions 50 of intermediate sections 34 of installation strips 26 will not pinch by teeth 51 of hinge device 10. At the same time, when door panels 12 are in the closed state, toothed portions 50 still mesh with teeth 51 to keep door panels 12 together.

Referring to FIGS. 1 and 9, a through-hole 68 is provided in each shaft portion 62 for receiving a screw 70. Lower end faces of installation strips 26 engage with a common washer 72, and a lower end face of each door panel 12 engages with a connecting board 74 by screws 76. Each screw 70 extends through one of connecting boards 74 and washer 72 and extends into through-hole 68 in a lower end of a corresponding shaft portion 62 to position connection strip 28 in the longitudinal direction and to prevent connection strip 28 from moving relative to installation strips 26. Furthermore, upper end faces of installation strips 26 engage with a common washer 78. Washer 78 is fixed by screws 70 screwed into the upper ends of shaft portions 62 to prevent screws 70 from getting loose.

FIGS. 10 and 11 show a hinge device 10 of a second embodiment according to the present invention modified from the first embodiment. In this embodiment, ends 67 of cover portion 64 do not protrude beyond shaft arms 60, and inner ends 40 of second side walls 37 of installation strips 26 do not include shields 52. Coupling slots 54 of

installation strips 26 are formed only by the inner faces of toothed portions 50. Furthermore, cover portion 64 is spaced from shaft portions 62 of connection strip 28 by an appropriate spacing, and toothed portion 50 and extension 46 of each installation strip 26 are spaced from each other by an appropriate spacing, allowing screws 45 to pass  
 5 through the spacings to fix installation strips 26 to door panels 12.

FIGS. 12 and 13 show a hinge device 10 of a third embodiment according to the present invention modified from the second embodiment. In this embodiment, each installation strip 26 includes first and second installation strip members 26a and 26b. First installation strip member 26a includes second side wall 37 and connection wall 38,  
 10 and second installation strip member 26b includes first side wall 36 and extension 46. After first installation strip member 26a is coupled to an associated door panel 26 by screws 45, second installation strip member 26b is coupled with first installation strip member 26a. With this provision, installation strips 26 can be assembled on door panels 12 more conveniently. In this embodiment, first installation strip member 26a is provided  
 15 with two first hook portions 80, and second installation strip member 26b is provided with two second hook portions 82 respectively engaged with first hook portions 80 of first installation strip member 26a.

FIG. 14 shows a hinge device 10 of a fourth embodiment according to the present invention modified from the first embodiment. Hinge device 10 of this  
 20 embodiment is adapted to be mounted to thin door panels 12. In this embodiment, outer ends 42 of first and second side walls 36 and 37 of each installation strip 26 protrude from connection wall 38 and away from inner end 40 in the width direction to form two extension ears 84, with each extension ear 84 being hollow. Installation slot 44 of each installation strip 26 is defined between extending ears 84. A coupling strip 86 made of  
 25 soft material is mounted in each installation slot 44. Each coupling strip 86 includes a coupling slot 87 for receiving inner end 24 of an associated door panel 12, such that each

installation strip 26 can be fixed to inner end 24 of the associated door panel 12. Furthermore, a substantially U-shaped frame strip 88 is mounted in extending ears 84 of each installation strip 26 for enhancing the engagement of upper and lower sections 30 and 32 and intermediate section 34 of each installation strip 26. Further, each installation  
5 strip 26 has a holder 90 for engaging with a top cover for covering an upper end of hinge device 10.

Although specific embodiments have been illustrated and described, numerous modifications and variations are still possible without departing from the essence of the invention. The scope of the invention is limited by the accompanying claims.

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## CLAIMS

1. A hinge device (10) for a folding door (14), with the folding door (14) including two door panels (12) each having an inner end (24), with the hinge device (10) adapted for connecting the inner ends (24) of the two door panels (12) to allow the two door panels (12) to pivot synchronously upon movement of one of the two door panels (12), with the hinge device (10) comprising:

two installation strips (26), with each of the two installation strips (26) extending in a longitudinal direction and including a first side wall (36), a second side wall (37) spaced from the first side wall (36) in a thickness direction perpendicular to the longitudinal direction, and a connection wall (38) connected between the first and second side walls (36, 37), with each of the first and second side walls (36, 37) including inner and outer ends (40, 42) spaced from each other in a width direction perpendicular to the longitudinal and thickness directions, with the outer ends (42) of the first and second side walls (36, 37) respectively protruding from the connection walls (38) and away from the inner ends (40) of the first and second side walls (36, 37) in the width direction, with an installation slot (44) defined between the outer ends (42) of the first and second side walls (36, 37) and adapted for receiving the inner end (24) of an associated door panel (12), with each of the two installation strips (26) further including a toothed portion (50) extending from the inner end (40) of the second side wall (37) thereof toward but spaced from the first side wall (36) thereof, with the toothed portions (50) of the two installation strips (26) meshed with each other;

a connection strip (28) extending in the longitudinal direction and including a cover portion (64) and two shaft arms (60) located in the cover portion (64) and spaced from each other, with each of the two shaft arms (60) including an outer end connected to the cover portion (64), with each of the two shaft arms (60) further including an

inner end forming a shaft portion (62), with shaft portion (62) of each of the two shaft arms (60) engaged in the toothed portion (50) of one of the two installation strips (26), with the two installation strips (26) being pivotable relative to the connection strip (28) between a first position and a second position, allowing the two door panels (12) to pivot synchronously upon movement of one of the two door panels (12);

wherein when the two installation strips (26) are in the first position, the door panels (12) are unfolded, and the connection strip (28) is located in the two installation strips (26), and

wherein when the two installation strips (26) are in the second position, the door panels (12) are folded, and the cover portion (64) of the connection strip (28) is partially located outside of the two installation strips (26).

2. The hinge device according to claim 1, with each of the two installation strips (26) further including an extension (46) extending from the inner end (40) of the first side wall (36) thereof toward but spaced from the second side wall (37) thereof, with the extension (46) of each of the two installation strips (26) including a distal end (48), with the toothed portion (50) and the distal end (48) of the extension (46) of each of the installation strips (26) spaced from each other and defining an opening (56) therebetween,

wherein when the two installation strips (26) are in the first position, the extensions (46) of the two installation strips (26) abut with each other, and the distal ends (48) of the extensions (46) are located at a middle of the cover portion (64) of the connection strip (28), and

wherein when the two installation strips (26) are in the second position, the cover portion (64) of the connection strip (28) is located between the distal ends (48) of the extensions (46) of the two installation strips (26).

3. The hinge device according to claim 1, with each of the two installation strips (26) further including a shield (52) extending from the inner end (40) of the second side wall (37) thereof toward but spaced from the connection wall (38) thereof, with a coupling slot (54) defined by the shield (52) and an inner face of an associated toothed portion (50) and being substantially semi-circular in cross section, with each of the shaft portions (62) of the connection strip (28) engaged in the coupling slot (54) of one of the two installation strips (26).

4. The hinge device according to claim 3, with a spacing between centers of the shaft portions (62) of the connection strip (28) being slightly smaller than a spacing between centers of the toothed portions (50) of the two installation strips (26), with the cover portion (64) having substantially C-shaped cross sections, with the cover portion (64) including two ends (67) protruding beyond the two shaft arms (60), with the two shaft arms (60) located between the two ends (67) of the cover portion (64), with a length of each of the two ends (67) of the cover portion (64) beyond an associated shaft arm (60) corresponding to the shield (52) of an associated installation strip (26).

5. The hinge device according to claim 4, with each of the two installation strips (26) further including an extension (46) extending from the inner end (40) of the first side wall (36) thereof toward but spaced from the second side wall (37) thereof, with the extension (46) of each of the two installation strips (26) including a distal end (48), with the toothed portion (50) and the distal end (48) of the extension (46) of each of the installation strips (26) spaced from each other and defining an opening (56) therebetween, with the cover portion (64) including two arc-shaped sections (69), with each of the two arc-shaped sections (69) connected to the outer end of a corresponding shaft arm (60) and having a center located in one of the shaft portions (62) or one of the coupling slots (54), with the two arc-shaped sections (69) connected with each other to form a recessed portion (66),

wherein when the two installation strips (26) are in the first position, the distal ends (48) of the extensions (46) of the two installation strips (26) are received in the recessed portion (66) of the cover portion (64) of the connection strip (28).

6. The hinge device according to claim 4, with the center of the coupling slot (54) of each of the two installation strips (26) located between a distal end of the shield (52) and the second side wall (37) of the installation strip (26).

7. The hinge device according to claim 4, with each of the two installation strips (26) including an upper section (30), a lower section (32), and an intermediate section (34) between the upper and lower sections (30, 32), with the toothed portion (50) of each of the two installation strips (26) including a plurality of teeth (51) formed on an outer face thereof, with a number of the plurality of teeth (51) of the toothed portion (50) at the intermediate section (34) of each of the two installation strips (26) being less than a number of the plurality of teeth (51) of the toothed portion (50) at each of the upper and lower sections (30, 32).

8. The hinge device according to claim 1, with each of the two installation strips (26) including first and second installation strip members (26a, 26b), with the first installation strip member (26a) including the second side wall (37) and the connection wall (38), with the second installation strip member (26b) including the first side wall (36), with the first installation strip member (26a) including two first hook portions (80), with the second installation strip member (26b) including two second hook portions (82) respectively engaged with the first hook portions (80) of the first installation strip member (26a).

9. The hinge device according to claim 1, with the outer ends (42) of the first and second side walls (36, 37) of each of the two installation strips (26) respectively protruding from the connection walls (38) and away from the inner ends (40) of the first and second side walls (36, 37) to form two extension ears (84), with the

installation slot (44) of each of the two installation strips (26) defined between the two extending ears (84), with a coupling strip (86) mounted in the installation slot (44) and including a coupling slot (87), with the coupling slot (87) adapted to receive the inner end (24) of an associated door panel (12).

10. The hinge device according to claim 1, with the connection wall (38) of each of the two installation strips (26) including a hole (47), with a screw (45) adapted to extend through the hole (47) to fix each of the two installation strips (26) to the inner end (24) of an associated door panel (12).