

Sliding door module

The invention relates to a sliding door module for sealing a passage opening in a wall member, which module comprises an at least substantially horizontally movable door unit, a frame unit attachable to the wall member, 5 said frame unit comprising two frame members between which said door unit is moved, and defining an opening plane parallel to which the door unit moves across the passage opening and sealing means for providing a seal between the door and frame units when the door unit is closing the passage 10 opening.

A water-tight sliding door in a ship requires there to be good sealing contact between the door unit and the frame unit, which surrounds the passage opening. The contact between the door unit and the frame unit 15 must, therefore, be continuous along the entire contact path. A sliding door module for use in a ship is usually required to have high torsional and bending resistivity, as a result of which the frame and the door units are usually both rigid. One known embodiment is described 20 in Finnish Patent Publication 61946 and in this disclosure, the frame and the door units are provided with flexible members, by which a continuous sealing contact between the door unit and the frame unit is provided.

For the closure of the passage opening, the door 25 unit in known modules is controlled by guiding wedge members so that the door unit approaches the frame unit at a small approach angle. In this way, the door unit and the frame unit, or at least the sealing means thereof, make rubbing or sliding contact prior to the movement 30 of the door unit stopping. A similar rubbing contact also arises during the initial opening phase of the passage. One drawback of this rubbing phenomenon is that the sealing means wear. Furthermore, some part of the driving power of the prime mover provided to move the 35 door unit is utilised in overcoming this rubbing friction.

The present invention seeks to provide a water-tight

17

- 2 -

sliding door module, in which a rubbing contact between cooperating sealing surfaces is avoided. What constitutes the invention is defined in the following claim 1. A tight seal or the disconnection of the tight seal without
5 the generation of rubbing friction is possible by displacing at least one movable member of the door unit in a direction normal to an opening plane defined by the frame. This displacement is carried out during the final phases of the motion of the door unit in a door-
10 closing action or in the initial phases of the motion of the door unit in an opening action.

A surprising extra advantage of a module according to the invention was discovered to be that the output power of the prime mover of the sliding door unit could
15 be reduced. This is a consequence of the fact that a door module according to the invention does not require guide wedges to be applied and preferably avoids any rubbing friction on the sealing means. In a module according to the invention the required thrust power
20 of the prime mover can be considerably below half of the thrust power required for a prior art door module of corresponding size.

In a preferred embodiment of module according to the invention, the displacement normal to the opening
25 plane and the door unit motion parallel to the opening plane are carried out at different times. The motion parallel to the wall member (or opening plane) is halted during the displacement normal thereto which either forms the water-tight seal or breaks it. A functionally pre-
30 ferred and convenient design of sliding door module from a manufacturing point of view has the frame unit and the door unit easily adjusted relative to each other and the module prefabricated for simple fitment to the wall member. Such a module can be manufactured at a
35 remote location and mounted directly on a ship's deck

or the like supporting surface in the wall member at the planned site of the passage. A favourable embodiment provides a self-supporting module, which can be directly connected to the wall and deck of a ship, for instance,
5 by welding.

The link member of the module according to the invention may comprise a slide element connected to a power transmitting transmission arm of the mechanism used to effect movement of the door unit across the passage opening, which slide element is movable parallel to a surface of the first door plate and is connected to a transfer element, which is displaced normal to the surface of the second door plate by engagement in a guiding groove which is located in a support member secured to the second door
10 plate.
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Alternatively, the link member of the module according to the invention may comprise a slot in a support element of one door plate and a force transfer bar movable in the slot, which bar is connected to a transmission arm
20 transmitting power from the mechanism used to effect movement of the door across the passage opening.

The magnitudes of the displacements of the door plates towards or away from each other can be so arranged, that the motion of the second plate is considerably larger than
25 the corresponding motion of the first plate.

Guide devices for the door unit can comprise a guide rail and a guide wheel movable therealong. This arrangement makes possible a good directional control of the door unit in the frame unit and at the same time keeps
30 the frictional forces to the lowest level possible. The support shaft can be attached, in a convenient embodi-

(19)

- 4 -

ment, to the first door plate and be movably supported from the second door plate, in order to facilitate their displacement parallel to the travel direction of someone passing through the passage opening. The shaft is, in this way, arranged to be movable in the plane of the passage opening. In order to retain the door unit in its closed position, the guide rail can include a depression in a separate guide lath, which is attached to the lowermost guide rail. The guide lath or its depression can be formed to be slightly inclined downwardly relative to the upper surface of the guide rail. The inclination of the depression can be so arranged, that the motion of the door unit is improved during the closure of the passage opening. The depression can also assist during the opening of the sliding door unit by ensuring that the door unit motion, which is parallel to the wall construction, is not started until the displacement normal to the door opening direction has been completed.

Embodiments of sliding door modules in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 discloses a partially sectioned front view of an embodiment of an opened sliding door module according to the invention, viewed in the direction along the passage opening,

Figure 2 shows a detail of Figure 1 on an enlarged scale,

Figure 3 shows an enlarged detail of a moving door unit seen from above,

Figure 4 shows the sliding door device partly sectioned and viewed parallel to the plane of the wall supporting the module,

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Figure 5 shows a detail of Figure 4,

Figures 6 and 6a show a magnified detail of Figure 4,

Figures 7 and 8 show two stages during the closure phase of the door unit, viewed as in Figure 1,

Figure 9 shows a guide and support system of the sliding door module according to the invention,

Figure 10 shows a modified arrangement at the bottom edge of the frame unit of a module according to the invention, and

Figures 11 and 11a show further embodiments of displacement gear for separating the parts of the door unit.

In the drawings a vertical bulkhead 1 and a horizontal bulkhead or a deck 2 of a ship are shown, to which a sliding door module according to the invention is mounted. For a secure and rigid attachment, the module is supported directly on the deck 2. The self-supporting module can be attached to the wall 1 and the deck 2 without any auxiliary reinforcing members, for instance by welding. The module includes a frame unit having frame members 3a and 3b, which include openings for the formation of a passage opening 4. The passage opening can be of rectangular shape, as shown, but other shapes (e.g. a circular opening) are possible. Frame members 3a, 3b and an end plate 3d attached by bolts 3f to a casing head 3c, form the frame unit inside which a door unit is moved in a direction L in order to close or to open the passage opening 4.

The door unit comprises two door plates 5a, 5b which are movably attached to each other so that the plates

5a, 5b can be displaced relative to one other along the passage direction of the opening 4. Motion of the door unit is provided by a hydraulic cylinder mechanism, a work cylinder 6 of which is attached by attachment members 7 to the end plate 3d. The work cylinder 6 is at least mainly inside the module. The movement of a power shaft 8 of the work cylinder 6 is effected in the directions of the arrow L. The motion of the door unit is guided along a guide lath 9a and by wheels 10 rolling along a guide rail 9 supporting the door unit. Each wheel 10 is journalled on a bearing 11.

In order to define a closed position of the door unit, the lath 9a is provided with shallow depressions 31 for the reception of the wheels 10. At least one edge of each depression 31 is slightly inclined in the direction L. A front edge 12 of the door unit closely confronts or contacts a stop surface 13 of the door frame in the final stage of closing the opening 4. Any back-recoil of the door unit from the stop surface 13 is prevented during the closure of the opening 4 by arranging the guide lath 9a to be downwardly inclined in the door-closing direction or by forming the depression 31 located nearest to the stop surface 13 with a downwardly sloping chamfer. Near its stop position, the door moves hereby mainly by means of its own inertia since the thrust action of the shaft 8 is stopped somewhat earlier during the closure of the opening 4. The passage opening is surrounded by a sealing member of the frame, for instance by a metal lath or a permanent portion of the frame element acting as a back surface, like, for example, a surface protrusion 14 provided around the opening 4 inside the module. Levers and switches 16 for operating the door are attached to frame elements 3a and 3b on outside surfaces of the module. The operating levers and switches 16 can also be mounted on that flange 15a of door module flanges 15, which is nearest to the stop surface 13.

22

Within the same location area a manually operated pump can be provided for emergency operation of the door. The location of a pressure reservoir and an electrically operated pump required for the hydraulic mechanism are not shown since they obviously can be located in a variety of different positions. Reference numeral 16a refers to an actuator device of a limit switch, which is operated by a movable pin 32, which can be spring-urged. Numeral 34 refers to a gasket.

10 Figure 2 shows a door unit, from which the door plate 5a has been removed for reasons of clarity and to show the link member used to control the separation of the door plates 5a, 5b. Reference numeral 17 refers generally to a guide device for guiding the movement of the door. For transmitting thrust to the door, a power transmission bolt 19 is passed through a hole in an end 18 of the shaft 8. Instead of the end 18 a ball joint can be provided on the end of the shaft 8. The bolt 19 transmits power via a yoke 20 and a joint 21 to an extension arm 22. Flanges 23a are attached to the door plate 5a and flanges 23b are attached to the door plate 5b. In the flanges an opening, slot, or groove 24 is provided for guiding the motion of the bolt 19. Reference numerals 19b refer to base washers holding the bolt 19 in place. Between the extension arm 22 and the end 18 is located the joint 21 which can be a ball joint. The motion of the extension arm 22 is guided by a guide 26. On the door plate 5b is attached a device 27-29, by which the motion of the extension arm 22 can be adjusted relative to the door plate 5b. The device comprises a guard arm 28, journaled on the door plate 5b or on the guide 26, and a guide roller 29 journaled on the arm 28. A guard 27 is mounted on the arm 28, which guard prevents the extension arm 22 moving relative to the door plate 5b. The arm 22 is thus used to move the guard 27 by pushing this in the closing direction

23

- 8 -

of the door. The arm 22 can move relative to the door plate 5b only when the guard 27 is in an unobstructed position. Motion of the door unit stops after a head or roller 29 of the guard arm 28 hits the door frame
5 or the guide device 17 and, as a result thereof, the guard 27 moves out of the way of the extension arm 22. Reference numeral 29a refers to a limit position of a guide roller 29. The functions of the guide roller 29, the extension arm 22 and the guide device 17 during the
10 opening and closing motion of the door unit are described hereafter.

The extension arm 22 is, in Figure 3, locked via the guard 27 to the door plate 5b, whereby the bolt 19 is at the same time at the right-hand end 24a of the
15 grooves 24 so that the separation between the door plates 5a and 5b is the smallest possible. The bolt 19 in Figure 3 is shown sectioned so that the circular washer 19b is not shown. The guard arm 28 is attached to the door plate 5b by a journalled peg 30. The motion of the door
20 unit corresponding to a closure and opening function is shown by an arrow L. Arrows S indicate the separation between the door plates 5a and 5b, which is effected by movement of the power transmission bolt 19 along the slots 24. The earlier described rail 9 also acts
25 as a guide for movements of the door panels in the direction S.

Frame elements 3a and 3b are attached to each other to form a water tight casing, inside which the door unit moves. The casing head 3c comprises an opening, through
30 which the door unit is mounted in the casing. The opening is closed by the head plate 3d, to which the hydraulic cylinder is attached, for instance by means of attachment bolts 3f. Figure 4 shows the sealing surfaces 14 on the frame element, the rail 9 and lath 9a, a wheel 10
35 journalled on its shaft 11 (which is attached to door plate 5a) and a bushing 46 which supports the shaft 11

from door plate 5b and allows an axially directed movement of the shaft 11 (see also Figure 5). The principal construction of the door plates 5a, 5b is partly shown in Figures 4 and 5. The figures correspond, during closure of the passage opening 4, to a situation just before the door plates separate. Each door plate is prestressed, so that in the vertical direction, the door plates 5a and 5b are nearest to each other within their central portion, when the door is in the open condition. Each door plate is provided by stiffeners so that the plate is flexible in the direction of the deflection shown in Figure 4. One stiffener construction is such, in which a stiffener bar is mounted in the L-direction at the surface of the door plate. The deflected door plate can at best be described to resemble a portion of a cylinder surface. The door stiffeners are arranged in the L-direction so that the door plate is rigid against such a deflection, in which one tries to bend the vertical edges of the door plates towards each other or away from each other. Reference numeral 9b refers to an adjustment lath located between the rail 9 and the door parts 5a, 5b. The small clearance between the lath 9b and the rail 9 is not shown.

A sealing arrangement between the door plate 5a and the frame element 3a is shown in greater detail in Figure 6. A gasket 34 is attached to the door plate 5a, for instance a rubber-elastic, a plastics or a metal band. The gasket 34 is shown located in a groove 25 so that the gasket is pressed into the groove as the compression increases. In this way the door plate and frame surface 14 are directly sealed one to the other. A suitably formed gasket can also be located along the back surface 14 so that this gasket is compressed between a surface 14b of the door and the surface 14. The application of a gasket material of this type is possible because sealing contact between the gasket and the door



or back surface 14 occurs only after the closure motion of the door unit has ceased. Thus no gasket wearing motion arises. Figure 6a shows another form of gasket which is easy to mount. This gasket is an effective seal against eventual rising water pressure, which acts to deflect the module outwards.

Figures 7-8 show the arrangement used to separate the door plates in one embodiment of door unit. During the final phase of closure motion of the door unit in the direction L, the guide roller 29 touches a guide surface 33a of a guide body 33, which is attached to the back surface 13 of the frame element and forms part of the guide device 17. The guide surface 33a is so arranged that the guide roller 29 moves vertically upwards into a grip member formed by the surface 33a and a protrusion 33b. The motion of the roller 29 relative to the door plate 5b is arranged to rotate the guard arm 28 around its attachment bearing 30 in the direction of the arrow A in Figure 8. The guard 27 is moved out of the way of the extension arm 22 by means of the rotation of the arm 28 so that the front edge 12 of the door and the stop member 13 of the frame element contact each other. The bolt 19 begins to move in the grooves 24 (arrow B). Simultaneously with a B-directed motion of the bolt 19, the bolt runs along the guide grooves 24 in the guide plates 23a, 23b and urges the door plates 5a and 5b outwards in the directions of the arrows S. The form of the guide grooves 24, the function of the guard device 27-29 and the guide surface 33a as well as motion B are controlled by a limit switch 32 and the cylinder 6 and are so arranged, that the motion B is halted as soon as a water-tight seal has been achieved with the sealing gasket 34. The thrust of the hydraulic cylinder 6, via the power shaft 8 in the direction B is halted when the arm 22 actuates the limit switch 32.

During the opening of the door unit to free the



passage opening 4, the gasket 34 is first decompressed (e.g. from its contact with the back surface 14) by means of the cylinder 6, moving the power shaft 8, the bolt 19 and the arm 22 in the opposite direction relative to the direction B. During this phase of the operation, the door plates 5a and 5b are not moved in the opening direction. This absence of movement arises because of the protrusion 33b engaging the guide roller 29, which is connected to the door plate 5b via the guard arm bearing. Further the front wheel 10 is located in its depression 31, and this further stabilises the door unit in its closed position. During the final phase of the motion of the bolt 19 in the grooves 24, the arm 22 is moved to such a position that guard 27 can assume its initial position (Figure 2). The power of the shaft 8 is now transmitted to the door leaves 5a and 5b so that the actual opening motion of the door unit starts.

Two modifications of the sliding door module are shown in Figures 9-10, of which the construction shown in Figure 9 comprises a separate guide lath 14a arranged around the passage opening 4. In order to provide a passage, not cluttered by bars over which people could trip, turnable threshold ramps 35 can be arranged to overlie the bars. Threshold ramps 35 and the guide lath 9a form an unobstructed bridge arrangement in an open passage opening 4. In order to arrange a safe closure function, plough-like turning devices 36 are arranged at the lower portion of the front edge 12 in the door plates 5a, 5b. Each turning device 36 turns the associated threshold ramp 35 around a hinge 37, when the door unit starts to close. Each ramp 35 is turned until it is out of the way of the respective door plate 5a, 5b. The position of each ramp 35 in the closed condition of the door unit is shown at 38 in Figure 10 by broken lines. Starting from the positions 38, each threshold ramp 35 will form a bridge by means of its own torque,

57

- 12 -

when one opens the door unit.

The water tightness of a sliding door module according to the invention is equally good in both passage directions of the passage opening 4. In the closed position of the door, the gasket in each door plate 5a, 5b is tightly compressed against the surface 14 over a path completely surrounding the opening 4. As an example of the operation of the door module, a situation will now be considered, in which as a result of a fracture in a ship's hull or due to some other reason, the water level is rising on just the 5a side of the door unit. The water pressure against the plate 5a tends to open the joint between the back surface 14 of the frame 3a and the gasket 34 and water will enter between the plates. However, a flexible attachment exists between the door plates 5a, 5b by means of the shaft 11 and the bushing 46. As a result of this, the rising water level inside the door module will thrust the door plate 5b against the frame 3b, whereby the gasket 34 on that side is pressed more tightly against its confronting back surface 14. A similar operation clearly arises if the water pressure rise initially starts from the side of the door plate 5b.

In Figure 11 a modified construction of the door unit for guiding the functions in the L- and S-directions is shown. The power shaft 8 extends along the direction of the door plates 5a and 5b so that the end 18 is in the vicinity of the front edge 12 of the door. The power is transmitted from the shaft 8 via the end 18 and a transfer bolt 39 to a slide 40. The slide 40 is movable in the L-direction, if the guard 27 is in a position which releases the shaft 8 from the door plate 5b. The slide 40 slides through guides 41, which are attached to the door plate 5a. The slot 24 in the support plate 23b is substantially similar to that shown in Figure



3. A corresponding further modification (Figure 7) is possible by arranging the groove 24 in the flange 23b to be parallel to the door plate 5b and those grooves 24 in the flanges 23a inclined relative to the plate 5a as shown in Figure 3. The slide 40 includes a stub 42, in which a guide roller 43 is journaled, which roller is moved in the groove 24 of the flange 23b as shown in Figure 11.

The guard 27 is journaled on the guard arm 28 at a bearing 45 and is guided by a guide 44 attached to the door plate 5b. The dimensions of the guard 27, the extent of the rotation A of the guard arm 28, the location of the bearing 45 and a clearance 44a in the guide 44 which receives the guard 27 are chosen so that the guard 27 is movable in the vertical directions C as the arm 28 is turned.

Figure 11a shows a modification of the slide arrangement shown in Figure 11. In this Figure, two slide arms 40 are mutually connected by a connector plate 47. The door frame is provided with a U-shaped actuator-locking member 17' which acts in association with a guide slot 29b in a retainer arm 28'. The retainer arm 28' comprises a retainer protrusion 27', the function of which is similar to the earlier described guards 27. The arm 28' is turned in the direction A after the slot 29b engages the member 17' so that the slide arms 40 are free to move in the direction L. For opening the door, the slide arms 40 move opposite to the opening L-direction (i.e. to the right), until the roller 43 engages the end of the slot 24 in the support plate 23a indicating the end of the S-shift operation. The total power of the shaft 8 now directly acting on the plates 5a and 5b will cause the arm 28' to release its grip from the member 17' and the arm 28' will be turned to the initial state shown in Figure 11a. Figures 11 and 11a show such construc-



- 14 -

tions, in which arm(s) 40 move(s) mainly parallel to the door plate 5a whereby the door plate 5b is shifted in its S-direction relative to the plate 5a and to the arm(s) 40/shaft 8.

5 The invention is not limited to the embodiments illustrated since several modifications thereof are possible within the scope of the following claims. Stub 42 (Figure 11) and guide 41 can be adjusted to contact each other, when the arm 12 is in its extreme location to
10 right or left.



- 15 -

CLAIMS

1. A sliding door module for sealing a passage opening in a wall member, which module comprises an at least substantially horizontally movable door unit, a frame unit
5 attachable to the wall member, said frame unit comprising two frame members between which said door unit is moved, and defining an opening plane parallel to which the door unit moves across the passage opening and sealing means
10 for providing a seal between the door and frame units when the door unit is closing the passage opening, wherein the door unit is formed from a pair of door plates connected via a link member which allows relative movement between the door plates, within the frame unit, in a direction
15 normal to the opening plane defined by the frame unit to effect or to break a seal between each door plate and a respective one of said frame members, and the module includes a common mechanism to effect movement of the door unit across the passage opening and actuation of said link member to effect said relative movement of the door plates
20 during the final stages of a door-closing operation to effect the seal and during the initial stages of a door-opening operation to break the seal.

2. A module according to claim 1, in which during a door-closing operation the normal displacement is effected
25 after motion of the door unit parallel to the opening plane is completed, and in which the normal displacement is carried out prior to any motion of the door unit parallel to the opening plane during a door-opening operation.

3. A module according to claim 1 or 2, in which the
30 link member comprises a slot in a support element of one door plate and a force transfer bar movable in the slot, which bar is connected to a transmission arm transmitting power from the mechanism used to effect movement of the door unit across the passage opening.

35 4. A module according to claim 1 or 2, in which the link member comprises a slide element connected to a power

(2)



- 16 -

transmitting transmission arm of the mechanism used to effect movement of the door unit across the passage opening, which slide element is movable parallel to a surface of the first door plate and is connected to a transfer
5 element, which is displaced normal to the surface of the second door plate by engagement in a guiding groove which is located in a support member secured to the second door plate.

5. A module according to claim 4, in which the
10 magnitude of the displacement of the second door plate relative to the frame unit is considerably larger than the corresponding displacement of the first door plate.

6. A module according to any preceding claim,
15 in which the door unit is guided in the frame unit by a guide rail and at least one guide wheel is provided on the door unit journaled on a support shaft attached to one door plate of the door unit and movably supported by another door plate of the door unit, so that during
20 displacement of the door plates one relative to the other, said support shaft moves relative to the said another door plate.

7. A module according to claim 6, in which the guide rail includes means for temporarily securing the door unit in its closed position.

25 8. A module according to claim 7, in which said means is a depression located in a guide lath which is attached to the guide rail.

9. A module according to claim 8, in which the
30 separate guide lath or at least the depression therein is so formed that its upper surface relative to the upper surface of the guide rail, is slightly downwardly inclined in the closing direction of the door unit.



22

- 17 -

10. A module according to any preceding claim, which is prefabricated, the frame unit being a self-supporting structure.

11. A module according to claim 10, in which said
5 module is supported from a ship's deck located below the frame unit.

12. A sliding door module substantially as herein-
before described with reference to and as illustrated
in Figures 1 to 8 of the accompanying drawings.
