This invention relates to ship doors and more particularly to watertight bulkhead doors which open and close automatically with a vertical sliding movement.

In accordance with modern practice, ships constructed both for peaceful intercourse and for war are divided by bulkheads into compartments, the bulkheads having doors by which the compartments are connected. In this manner, if one section of a ship is damaged from any cause, the compartments in which the damage has occurred may be shut off from the rest merely by closing the doors. Such practice, it has been demonstrated, frequently prevents the spread of a fire, and in case of hull damage, in many instances, prevents the ship from sinking.

It sometimes happens that in the confusion following a fire, collision, or battle damage, the doors to the compartments are not closed, or if closed, not in a watertight manner. It has therefore been long desirable to design bulkhead doors which can be opened and closed automatically, either from the bridge or other control stations on the ship, or also through instrumentalities located adjacent the doors themselves. It is a principal object of the invention to provide doors which will so function, and a control system which will actuate all such doors throughout the ship when so desired.

Another object of the invention is the provision of such a door, the actuating mechanism of which includes an improved system of linkage and rollers, whereby the operation is facilitated, the structure being such that upon final closing, the door effects a watertight closure.

Further, the invention provides for means to permit a trapped occupant to open the door temporarily for escape purposes after the same has been closed from the central station. Such escape opening and closing may be effected automatically by means adjacent the door, or, in the event of failure of the automatic means, by manually operated means similarly located. It is an important object of the invention to provide for such an arrangement.

Finally, it is an object of the invention to provide such a door which is of simple construction, capable of easy manufacture, and efficient in operation.

These and other objects and advantages will become more apparent from the following description and claims, when read with the accompanying drawings, in which:

Fig. 1 is a rear elevational view of a ship's bulkhead door made in accordance with the invention.

Fig. 2 is a perspective view of the same.

Fig. 3 is a longitudinal section taken on the line 3--3 of Fig. 1.

Fig. 4 is a horizontal section taken on the line 4--4 of Fig. 1.

Fig. 5 is a horizontal section taken on the line 5--5 of Fig. 1.

Fig. 6 is a detail perspective of the control lever and associated mechanism, and

Fig. 7 is a schematic diagram of the door and its control system.

The invention will be described as applied to a door for a ship's bulkhead, the bulkhead being provided with a door opening having a surrounding flange directed away from the door. The door is mounted for up and down vertical sliding movement between a position above the door opening to a position closing the opening. The door is provided with a channel member adjacent its periphery, the channel being filled with a sealing strip of rubber or the like. When the door is in its lowermost position it is automatically forced forwardly in the direction of the opening so that the sealing strip engages the flange surrounding the opening thus effecting a watertight closure.

Means are provided for raising the door automatically by compressed air or the like, such means being selectively controllable from the bridge of the ship or adjacent the door itself. Emergency manual means are also provided to raise the door, should the automatic means fail to function for any reason.

With particular reference to the drawings the reference number 20 indicates a bulkhead door frame adapted to be secured to an opening in a ship's bulkhead as by welding or the like. The bulkhead door frame is constructed of sheet steel or the like and may be conveniently reinforced by a plurality of metal strips such as 21.

The bulkhead door frame 20 is provided with a door opening 22 (see Figs. 4 and 5), the edge of the opening being framed by a flange 23 integral with the bulkhead door frame 20 and directed outwardly from the plane of the door.
Rigidly secured to the bulkhead door frame 20 by means of the supporting members 24 (see Fig. 2) are spaced vertical guide tracks 25 and 26. These are spaced from the bulkhead door frame 20 and are disposed adjacent each side of the door opening 22. The guiding tracks 25 and 26 may be of sheet steel or the like and are rectangular in section with a longitudinal opening or slot 27 on the sides facing the door side member 36 (Figs. 2, 4 and 5).

The door, indicated by the reference number 28 is comprised of a sheet metal outer face 29 backed and reinforced by a frame structure comprised of a top member 30, a bottom member 31, intermediate horizontal members 32, 33, 34, and 35, and pairs of vertical side members, 36, 37, and 38, 39. The members comprising the frame structure are joined to each other as by welding or the like, or in some instances may be integrally formed. The sheet metal outer face 29 of the door 28 is secured to the frame structure preferably by welding.

With reference to Figs. 4 and 5, it will be noted that the outer vertical side members 36 and 38 also extend beyond the plane of door 28 and toward the bulkhead door frame 20. The sheet metal outer face 29 of the door is provided adjacent its periphery with an angle molding 40, which has a portion 41 secured to the door face 29, and terminates in a laterally directed flange 41.

A sealing strip 42 of rubber or the like is disposed in the channel formed by the angle molding 40 and that portion of the latter where the laterally directed flange 41 is provided. The cross rod 72 is aligned with the lateral flange 41 and aids to hold the sealing strip 42 in place.

When the door 28 is in closed position (Figs. 1, 2, 4 and 5), the sealing strip 42 engages the flange 43 surrounding the door frame opening, thus effecting a watertight closure.

The door 28 carries a plurality of rollers 43, 44, 45, 46, and 47, on each side, which rollers are disposed in the vertical guide tracks 25 and 26. Rollers 43, 44, 45, and 46 (on each side) (see Figs. 3 and 4) are mounted on spindles 48, 49, 50, and 51, which are carried by small rocker arms 52, 53, 54 and 55 respectively. At one of their ends the rocker arms 52, 53, 54, and 55 are secured to members 36, 37, 38, and 39 respectively. These members are supported in journals 60, 61, 62 and 63, respectively, which are rigidly secured to the vertical side members 36, 37, 38, and 39, of the frame structure.

The other ends of the rocker arms 52, 53, 54, and 55, on each side of the door are pivotally connected together by a long vertical link 64. It is to be understood that there are two of such links 64 and 65, one for each set of rocker arms 52, 53, 54, and 55.

The door, on each side at the bottom, carries the rollers 47. These rollers 47 are also adapted to ride in the guide tracks 25 and 26. These rollers serve a special purpose which will be later described.

Each pair of the vertical side members 36, 37, and 38, and 39 has a journal 66, 67, secured thereto. Each of these journals 66 and 67 supports an axle 68, 69, on which are mounted pairs of spaced lever arms 10, 17, and 11, 17' (see Figs. 1 and 2). A cross rod 72 passes through openings in the other ends of these lever arms, and, as will be clearly seen in the drawings, this cross rod 72 extends at each end to points laterally beyond the guide tracks 25 and 26 where the ends of the cross rod 72 are connected to the chains 73 and 74 for a purpose to be described.

Intermediate their ends the pairs of spaced lever arms 10, 17, and 11, 17' are connected by a cross rod 70. A series of coil springs 76 are connected at one end to this cross rod 70 and at the other end to the intermediate horizontal member 33 integrally mounted on the door structure. The springs 76 exert a downward pull on the cross rod 70 thus urging the lever arms 10, 17, 11, 17' downwardly to the position shown in Fig. 2.

Each link 64, 65 has an offset link 77, 78, pivotally connected thereto as at 79, 79'. Links 77 and 78 are offset from links 64 and 65, respectively. The other ends of these offset links 77, 78 are disposed respectively between the spaced lever arms comprising each pair, and are provided with holes through which pass a spindle 50 (see Fig. 3) which is carried by the lever arms 70, 10, 17, 11, 17'. Each link 77 and 78 is thus pivotally connected to a pair of the lever arms. When the lever arms 10, 17, 11, 17' are in their lower positions (Figs. 2 and 3), the points of pivotal connection (see Fig. 3) are positioned substantially below the journals 66 and 67.

From Fig. 3 it will be observed that the guide tracks 25 and 26 are somewhat larger than necessary to accommodate the rollers 43, 44, 45, and 46. However, the lower rollers, such as 47, are of a diameter which substantially occupies all of the space in the guide tracks, except at the base, the vertical side members 36, 37, 38, and 39 being materially enlarged in the direction of the bulkhead door frame. Here each guide track is provided with a ledge 81 which joins with a forward wall 82.

From this description and an examination of the drawings, it should now be apparent that as the door is lowered from its raised upper position, it will be guided in its descent by the rollers which ride in the guide tracks. The door in its descent is maintained in a plane which is slightly rearwards of the plane of the door opening, partly by virtue of the lowermost rollers 47. It is only when these lowermost rollers reach the ledges 81 and these rollers enter the enlarged bottom portions of the guide tracks 25, 26 that the door may be moved forwards against the opening so that the sealing strip 42 (Figs. 3, 4 and 5) may engage the flange 43 surrounding the door openings. Just how this movement is accomplished will now be described.

It has previously been mentioned that the ends of the cross bar 72 are connected to chains 73 and 74. These chains pass upwardly over pulleys 83 and 84 respectively. The pulleys are mounted on the upper ends of pistons 85 and 86 which are mounted in the cylinders 87 and 88 respectively. The cylinders are conveniently secured to the outer surfaces of the guide tracks 25 and 26 by any suitable means such as by welding. The other end of the chain 73 may be anchored to the guide track 25 adjacent the upper end of the cylinder 87. The other end of the chain 74 is anchored within the housing 89 of a braking device (Figs. 1 and 2).

When the door is to be raised the cylinders 87 and 88 are adapted to be supplied through a valve structure 90, with air under pressure from a suitable source. As a consequence, the pistons 85 and 86 rise in the cylinders 87 and 88, and the chains 73 and 74 are pulled upwardly exerting an upward force on the cross rod 72 and pivoting

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the lever arms 70, 70' and 71, 71' about their axles 68 and 69 against the action of the springs 76. This movement of the lever arms 70, 70' and 71, 71' effects an upward movement of the offset links 77 and 78 and also of the long links 64 and 65 connected thereto. This in turn causes the rocker arms 52, 53, 54, and 55 (on each side) to pivot upwardly, forcing the rollers 43, 44, 45 and 46 (on each side) against the forward surface of the guide tracks 25, 26, thus permitting the door to move rearwardly from its engagement with the flanges 23 surrounding the door opening. In such position the lowermost rollers 47 may ride over the ledges 81 (Fig. 3) and enter the narrow portions of the guide tracks.

Continued upward movement of the chains 73 and 74 (caused by continued upward movement of the pistons 95 and 96) will cause the door to be moved vertically upward, the rollers in the guide tracks facilitating such upward movement.

To lower the door, the air pressure is permitted to escape from the cylinders 81 and 88 gradually. The door descends by gravity, again guided by the rollers running in the guide tracks. The lowermost rollers 47 (on each side) ride on the forward surface of the guide tracks, 25, 26 thus maintaining the door in a vertical plane slightly rearwardly of the plane of the door opening.

Until the door reaches its lowest position these rollers 47 also prevent the springs 76 from pivoting the lever arms 70, 70' and 71, 71' to the position shown in Fig. 2. This is so because the links 54 and 55 are in raised position, the rocker arms 52, 53, 54, and 55 are pivoted upwardly, and the lowermost rollers 47 (by reason of their engagement with the forward surface of the guide tracks) have forced the rollers 43, 44, 45, and 46 against the rear surface of the guide tracks in such a position as to prevent a downward pivoting of the rocker arms.

When, however, the door reaches its lowest position these rollers 47 ride over the ledges 81 (Fig. 3) and enter the enlarged bottom portions of the guide tracks. The rocker arms 52, 53, 54, and 55 are now free to pivot downwardly and such downward pivoting movement is effected by the springs 76 which move the lever arms 70, 70', 71, 71' downwardly thus moving the links 64 and 65 downwardly. Such downward pivoting movement of the rocker arms 52, 53, 54 and 55 causes the rollers 43, 44, 45 and 46 (on each side) to bear against the rearward surfaces of the guide tracks, which forces the door to move forwardly into the plane of the opening. It will be noted that the springs 76 thus exert their full force at the moment required to close the door slightly. In such position, as previously mentioned, the sealing strip 42 (Figs. 3, 4 and 5) engages the flange 23 surrounding the door opening whereby a water-tight closure is effected.

In the event of failure of the air supply or the apparatus for controlling the same, the door may be raised manually by turning the hand wheel 91 (Figs. 1, 2 and 4). This wheel 91 when rotated, turns a drum 92 (Fig. 7) disposed within the housing 89 (Fig. 2) on which the drum the end of the chain 74 is wound. It will be apparent that turning the drum 92 will pull the chain 74 and thus raise the door. The shaft 93 which the wheel 91 turns, and the drum 92, are connected through gearing (not shown) so as to facilitate the manual raising of the door. The housing 89 is filled with a quantity of heavy oil which effects a braking action to retard the descent of the door after the handle 91 has been released. Thus, when it is necessary to open the door manually for escape purposes, the braking action of the heavy oil will retard the closing of the door sufficiently to permit the operator to escape through the door after releasing the handle 91. From Fig. 4 it will be noted that a second manually operated wheel handle 94 is provided to permit the door to be actuated from the front side as well.

The valve 90 for controlling the admission of air to the cylinders 87 and 88 for effecting automatic operation of the door, is shown in detail perspective in Fig. 6. A control system is diagrammatically shown in Fig. 7. Referring to the latter figure first, the reference numeral 95 indicates an air compressor which is connected by a conduit 96 to a control valve 97 located advantageously in the bridge of the ship. This main control valve 97 in the bridge of the ship connects through the conduit 98 and conduit 99 with the valve 90 adjacent the door 33. The jet 98 is disposed in this line. A conduit 90 connects the siphon jet 97 with a pair of fusible plugs 92 and 93, one of which is located on each side of the bulkhead 20 in which the door is located. Another conduit 96 extends from the valve 90 back to the air compressor 95 through a check valve 106. This valve 90 may be supplied with air from the air reservoir 107 through the connecting conduit 105 (which comprises the emergency line). 108, 109, 110, 111, 112, 113 each represent a control valve leading to bulkhead doors located in various parts of the ship.

In Fig. 6, the valve 90 adjacent the door 22 is shown as controlled by an operating handle 114 secured on the shaft 115 which actuates the valve. Mounted above the valve 90 in the conduit leading to the cylinders 87 and 88, is a check valve 116, the purpose of which is to retard the escape of air from the cylinders to prevent the door from closing too rapidly and causing damage upon striking the bottom. Mounted on the shaft 115 is a lug 117 having a portion 118 adapted to engage a stop member 119. The stop member 119 is mounted in a cylinder 120 which houses also a heavy spring (not shown) which urges the stop member 119 upwardly to the position shown in Fig. 6.

The system shown in Figs. 6 and 7 operates as follows:

The air compressor 95 is adapted normally to maintain air pressure in conduit 96, conduit 98, conduit 99 so that air under pressure is constantly supplied to the valve 90 for the door 22, as well as to the valves 108, 109, 110, 111, 112, and 113 for the other doors. This air pressure may be used at any one door for raising the same. For example, by operating the handle 114 (Fig. 6), the valve 90 can be actuated to cause air to pass to the cylinders 87 and 88, thus raising the door in the manner heretofore described. It is also this air pressure which maintains the door 22 (in fact, all of the doors) in raised position until the valve adjacent each door is again actuated. In the door shown (Fig. 6) the turning of the handle 114 to the position where the lug 118 strikes the stop member 119 will release the air pressure causing the door to descend.

The door shown can also be made to descend by turning the control valve 97 in the bridge to permit the air in the line to escape through the exhaust conduit 121 (Fig. 7). In fact, turning the control valve 97 in the bridge will cause all raised bulkhead doors in the ship to be lowered. Thus, in case of damage or disaster the officers...
on the bridge, by actuation of one control valve, are able to close all bulkhead doors throughout the ship.

Moreover, if a fire breaks out in any compartment, such as those separated by the bulkhead 20 with its door 28 (Fig. 7), the fusible plug 102 or 103 in that compartment will open up thus permitting the air in the conduit 99 to escape and consequently effecting a closing of the door. Assuming that the door 28 (Fig. 7) has been lowered either as the result of the opening of a fusible plug 102 or 103, or through operation of the control valve 97 on the bridge of the ship, it is still possible for an occupant of a compartment to raise the door in order to escape. This may be effected (Fig. 6) by turning the handle 114 so that the lug 116 depresses the stop member 119 (against the action of the spring which bears against the stop member). This further movement of the handle 114 actuates the valve 98 so as to connect the conduit 122 leading to the cylinders 87 and 88 (Fig. 1) with the emergency conduit 105, so that air under pressure is supplied from the air reservoir 107. However, as soon as the handle 114 is released, the spring pressed stop member 119 will move upwardly actuating the valve 98 to connect the cylinder 122 with the conduit exhaust port and consequently allow the door to close.

A trapped occupant of a compartment may also escape by manually turning either of the hand wheels 91 or 94 (Fig. 5) to raise the door in a manner heretofore described.

It should now be manifest that the invention possesses a number of advantageous features. In addition to those which have been enumerated, special attention is directed to the manner in which the lowermost rollers 41 maintain the door in a vertical plane rearwardly adjacent the plane of the opening at all times except when the door is in fully lowered position. As has been described, the lowermost portions of the guide tracks are enlarged so that when the door reaches its lowermost position, these lowermost rollers 41 may enter the enlarged track portion. This permits the springs 16 (Figs. 3 and 2) to exert their full force to actuate the links 64 and 65, thus pivoting the rocker arms 52, 53, 54 and 55 and causing the rollers 43, 44, 45 and 46 to bear against the rear surface of the guide tracks. This forcibly moves the door into fully closed position with the sealing strip 42 engaging the flange 23 (Figs. 3, 4, and 5) thus effecting a watertight closure.

Moreover, it will be noted that the greatest pressure required for raising the door, is at the beginning of the movement, namely the pressure required for pulling up the cross bar 72 (Fig. 2) against the action of the springs 76, actuating the linkage. Once the door begins its upward movement, the lowermost rollers 41 bear against the forward surface of the guide tracks. Because of this the air pressure for raising the door does not need to act against the force of the springs 16.

It is to be understood that the structure is shown and described by way of example only. Changes in the structure and arrangement of the parts may be made without departing from the invention which is only limited in scope by the language of the claims which follow.

I claim:

1. A water tight closure comprising a vertically movable door, a fixed framework having an opening adapted to be closed by the door, vertical guide means for the door mounted on said framework, a pair of cylinders mounted on said framework, pistons disposed in said cylinders and extending upwardly therefrom, a pulley mounted on the upper end of each piston, two chains each extending over a pulley, one end of each chain being secured to said framework, a leverage mechanism mounted on said door and having members engageable with said vertical guide means, spring means for actuating said cylinders, and a manually controlled valve disposed in said conduit means and mounted on said framework.

2. A door structure for the bulkheads of ships, comprising a door frame having an opening and an inwardly directed flange extending transversely of said door frame and surrounding the opening, a pair of parallel guide tracks secured to the frame and disposed respectively on opposite sides of the opening, said guide tracks being flared in the direction of the bulkhead at one end, a door provided with its edge adjacent its edge with a sealing strip, a plurality of rocker arms pivoted at one of their ends to the door, a plurality of rollers carried by said rocker arms and disposed in said guide tracks and of lesser dimensions than said guide tracks, a linkage mechanism supported by the door and connected to the other ends of said rocker arms, said door having rollers mounted thereon at each side near one edge, said last named rollers also being disposed in said guide tracks and having a diameter substantially equal to the width of its major portion of said tracks, compressed air means acting on said linkage for moving said door in said tracks to a position clear of the opening, means for moving said door to closed position, and spring means for actuating said linkage to pivot said rocker arms to force the rollers against said guide tracks thereby against the rear surfaces of said tracks when the door has reached its closed position, whereby the door is then forced forwardly into watertight engagement with the flange surrounding said opening.

3. A water tight closure comprising, a vertically movable door, a fixed framework having an opening adapted to be closed by said door, vertical guide tracks for said door mounted on said framework laterally of the opening, a plurality of rocker arms pivotally mounted at one of their ends on the side edges of said door, a roller mounted on each of said rocker arms for rotation with the axes of said rollers intermediate the ends of said rocker arms, links, one on each side, pivotally connecting the other ends of said roller arms, lever arms, one on each side, pivotally mounted at their inner ends to said door, a cross rod, extending transversely of the door and connecting the outer ends of said lever arms, a cross rod extending transversely of the door and connecting the lever arms intermediate their ends, members connecting each link to the inner ends of said lever arms, springs connected to the door below said lever arms and secured at one end to said door and having other ends to said last named cross bar, chain means connected to said first named cross bar, means for drawing said chain means upwardly to raise said door, said springs urging said links downwardly, and means mounted on said door and engaging in said guide tracks for blocking...
downward movement of said links and the connected rocker arms except when the door is in a position adjacent said opening.

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