April 9, 1940. F. H. SAINO ET AL 2,196,781

FIRE WALL, BULKHEAD, AND PANEL

Filed April 13, 1939 2 Sheets-Sheet 1

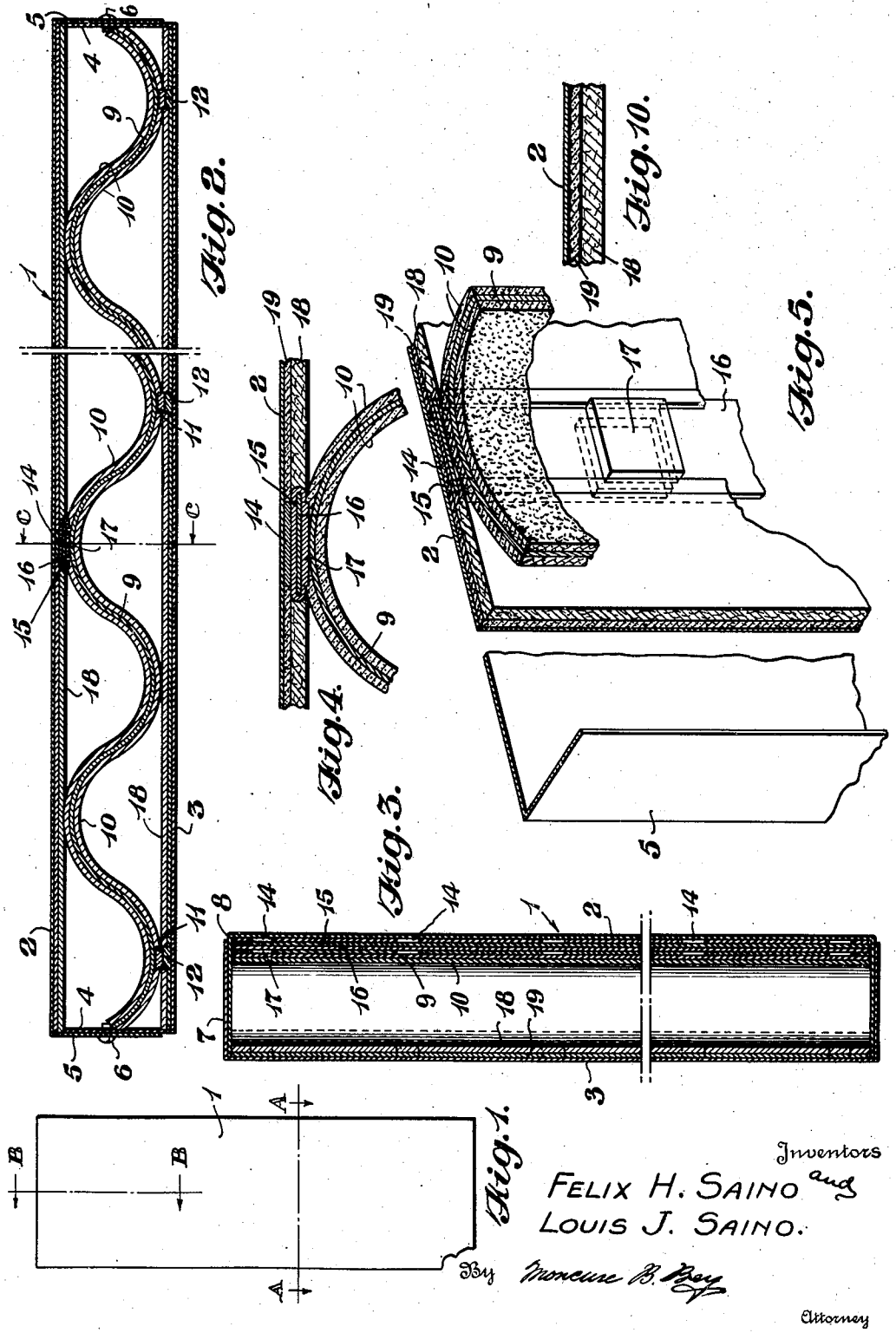


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 10.

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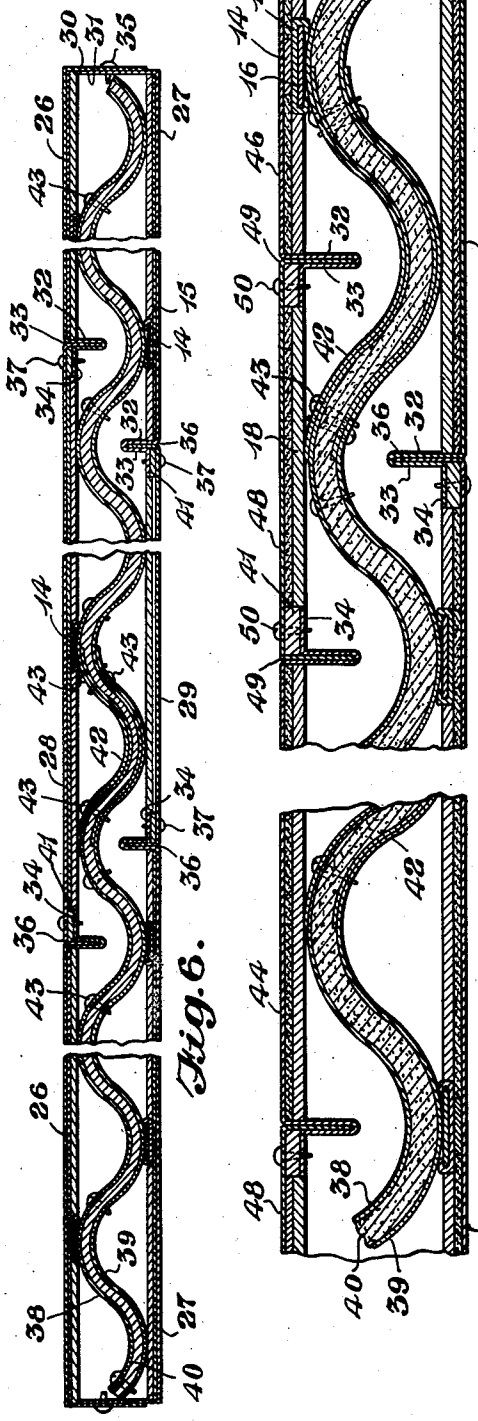


Fig. 6.



Fig. 7.

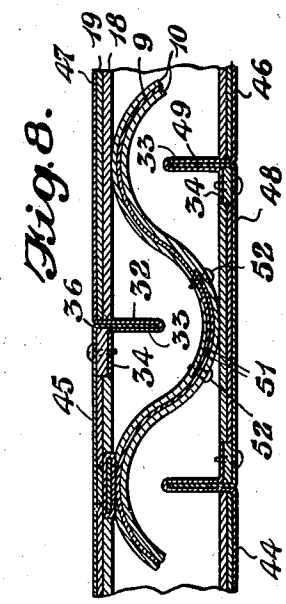


Fig. 8.

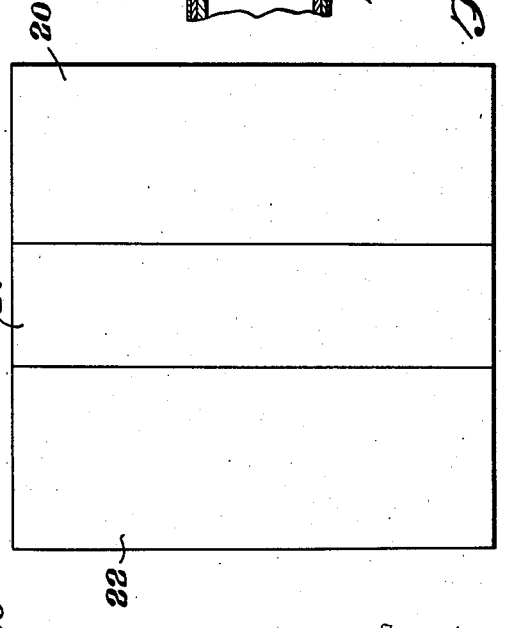


Fig. 9.

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2,196,781

# UNITED STATES PATENT OFFICE

2,196,781

## FIRE WALL, BULKHEAD, AND PANEL

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Application April 13, 1939, Serial No. 267,703

15 Claims. (Cl. 189—34)

The invention relates to fire resistant structures and more particularly has reference to fire walls, bulkheads and panels.

There are several fundamental requirements which must be satisfied in the design of structures of this type, which incidentally may be used in all classes of building construction as for example ship or marine construction as well as housing. These requirements include the use of incombustible and fire resistant materials in the construction of a wall or bulkhead capable of withstanding intensely high temperatures for long periods without collapse or failure. Also needed are materials which after heating will not crack, rupture or distintegrate when suddenly subjected to the cooling effects or the force of a liquid pumped against the structure at high pressure as for example by fire fighting apparatus. Expansion of the bulkhead due to heat must be taken into consideration. While expansion may be cared for by providing a flexible structure, the wall or bulkhead must be sufficiently strong to withstand the high stresses and strains to which it is subjected by reason of the expansion of its parts. The weight of the construction material employed is a highly important factor to consider and one which will influence the design of any type of building construction. Therefore as an essential requirement the wall or bulkhead must possess a low unit weight. Moreover the type of construction and materials employed must provide a wall which possesses the property of low heat transmission since as a fire safety structure its purpose is to delay the passage of heat, created by a fire on one of its sides, through the wall.

It is hence the major object of our invention to provide a novel fire resistant structure possessing all the essential requisites of good design and sound engineering principles.

An equally important object of our invention is the provision of a light weight fire resistant wall, bulkhead or panel constructed entirely of metal and fire insulating materials.

Another object of the invention is the provision in a hollow box like fire resisting wall or bulkhead of a core or fire screen formed of one or more members having insulation or fire proofing material fixed thereon or placed and secured between the members thereof.

Yet another object of the invention is the provision of novel means for mounting and securing a fire resistant core within the interior of a fire wall, bulkhead or panel.

A further object of our invention is to devise a splice or joint connection for securing and locking together the several separate sections making up a multi-section fire wall, bulkhead or panel.

A still further object of our invention is the provision of a thin hollow box like metal fire resisting wall, bulkhead or panel section having fire proofing and sound deadening material on the interior of each face thereof and a fire resistant core formed of one or more corrugated metal sheets having fire proofing material or insulant fixed thereon or placed and secured between the sheets thereof, the section being so constructed that it may be spliced and locked to one or more similar sections so as to form a strong but flexible wall or bulkhead of desired length.

With these and other objects in view, which may be incident to our improvements, the invention consists in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising our invention may be varied in construction, proportions and arrangement without departing from the spirit and scope of the appended claims.

One manner of practically effecting the concept of the invention comprehends the construction of a thin box like wall, bulkhead, or panel section of two thin sheet metal face plates. Within the wall section, which is of any desired height, there is mounted a fire resistant core formed of one or more thin corrugated sheet metal members, upon which or between which is placed fire proofing material or insulation. Also sheet material possessing fire proofing and sound deadening characteristics is attached to the interior of each face plate. A special construction permitting the mounting and securing of the fire resistant core within the bulkhead section is comprehended by the invention. This feature consists of keying the core to one or both face plates so that its connection to a plate or plates is a slidable connection, the core being fixedly secured in position on the complete assembly of the bulkhead section.

Included in the concept of the invention is the connecting and locking, through means of a joint construction, of one or more of the sections together so as to permit the formation of a wall of any desired length. In addition the section construction employed is of such design that assembly and erection is simplified and facilitated.

In order to make our invention more clearly understood, we have shown in the accompanying

drawings, means for carrying the same into practical effect without limiting the improvements in their useful applications to the particular constructions which, for the purpose of explanation, have been made the subject of illustration.

In the drawings:

Figure 1 is a front view of a single section fire resistant wall, bulkhead or panel.

Figure 2 shows a horizontal sectional view of the bulkhead on the line A—A of Figure 1.

Figure 3 shows a vertical sectional view of the wall or bulkhead on the line C—C of Figure 2.

Figure 4 is a partial horizontal sectional view, similar to Figure 2, showing in detailed enlargement the means for securing the sliding face plate and the fire resistant core to each other.

Figure 5 is a partial broken away perspective view on the line B—B of Figure 1 also giving details of the means employed for securing the sliding face plate and the fire resistant core to each other.

Figure 6 is a horizontal sectional view of a modification of the structure shown in Figures 1 through 5 and shows a wall, bulkhead or panel with a different type of fire resistant core and also made up of a plurality of panel sections with details of the splicing joint employed for connecting the sections together.

Figure 7 is a partial section view similar to Figure 6 but shows a modification of the splice or joint for the several sections.

Figure 8 is a partial horizontal sectional view showing in detail the type of wall or bulkhead illustrated in Figures 1 through 5 formed of a plurality of sections spliced together with the joint construction of Figure 7.

Figure 9 is a front view of a multi-section bulkhead unit such as any of the units shown in Figures 6 through 8.

Figure 10 is a partial sectional view showing in detail the manner of applying insulating material to a face plate of any wall, bulkhead or panel illustrated in the drawings.

Throughout the drawings similar reference numerals refer to like parts.

There is disclosed in Figures 1 through 5 a single section wall, bulkhead or panel 1 formed of the sheet metal face plates 2 and 3 having turned over sides 4 and 5 and turned over ends 7 and 8 which form top and bottom closures for the structure. If desired, the top and bottom closures may be formed by turning over both ends of one face plate only or one end only of each plate or by any combination of this practice. These plates are assembled by mounting them over each other and securing them with suitable fastenings such as the rows of screws 6. The width of the single section bulkhead is approximately four feet and is only limited by the width of sheet metal plates procurable from steel manufacturers, while the height of the panel will be eight or more feet depending on the height of the wall it is to form.

Within the wall or bulkhead there is mounted a fire resistant core or screen formed of a metal corrugated sheet 9 having a fire resistant insulant 10, such as vermiculite which will be described in detail hereinafter, on both sides thereof. This core is of a length equal to the height of the panel and is so placed within the face plates that the corrugations run vertically.

The fire resistant core is secured within the bulkhead by a plurality of filler blocks 11 and 12 respectively spot welded to the corrugated sheet 9 and the face plate 3 as well as to each other and also through means of a plurality of filler blocks or plates 14 welded to the face plate 2 and the several clip members 15 having overturned edges. The clip members form a keyway for key members 16 which are welded to filler blocks 17, which latter are in turn secured to the corrugated sheet of the core by spot welds. These clip and key members which are constructed from sheet metal strips are of a length which permits their extension from the top to the bottom of the bulkhead. They are located at and opposite the crown or summit of every fourth corrugation of the core for keying the latter to the face plate 2. Fillers 11 and 12 are positioned to be attached along the crown of every second corrugation. All fillers are welded to the face plates, in rows and to the clip and key members, and the core, at equal distances off center from each other. The fillers extend from the top to the bottom of the panel and are so aligned on the different parts that they will be opposite to each other. While we have described the clips and key members as positioned along and opposite the crown of every fourth corrugation of the core and the fillers 11 and 12 as located along and opposite every second corrugation it will be well understood that such construction may be varied as desired to permit these fastening elements to be spaced at greater or less intervals along the transverse axis of the face plates and the core.

Figures 2–5 and Figure 10 show the inner side of each face plate lined with sheet material 18 attached to a layer of granular material 19 which latter is cemented to the plate. Both materials 18 and 19 are fire insulants, the sheeting 18 being asbestos or the like and the layer 19 being formed of vermiculite or a similar substance. Such construction in addition to providing an effective fire resistant lining for the face plates also provides efficient sound insulation for the bulkhead or wall. The vermiculite covers the exposed inner surfaces of the face plates and several sheets of asbestos, extending from the top to the bottom of the bulkhead, are cemented to it, the width of the sheets being determined by the distance between rows of adjacent filler blocks and clip members. Fillers 12 and 14 on the face plates are used to compensate for the thickness of the asbestos and vermiculite and it will be appreciated that for the same reason fillers 11 and 17 are employed to compensate for the thickness of the insulant 10 or the core.

The construction details of the bulkhead of Figures 1 through 5 may be thoroughly understood by considering the assembly of its parts. The filler blocks 12 are welded in their proper positions to the face plate 3, this plate having had its sides 4 and ends 7 bent at right angles to its body and holes drilled therein for receiving the screws or other fastenings 6. A layer of vermiculite or other similar material 19 is cemented to the face plate and asbestos sheeting is then glued onto it between the rows of adjacent filler blocks. Face plate 2 is similarly prepared with rows of fillers 14 spot welded in their correct locations and the layers of insulating material 18 and 19 secured to the plate. To the fillers 14 are welded the clip members 15 which form the elongated keyway already described.

In the preparation of the core, rows of fillers 11 are welded on one side and along the crown of the corrugations of the core sheet 9 at points where they will contact fillers 12 on the face plate 3 when the bulkhead is assembled. On the other side of the core sheet, rows of filler blocks

17 are likewise welded to the summits of the corrugations at proper points for supporting the key members 16 which are then welded to them. The layers of fire proofing material or insulant may now be applied to each side of the corrugated core sheet. This insulant is placed first on one side of the corrugated sheet and then on the other, being built up evenly over the entire surface of each side of the sheet 9 to a thickness equal to that of the filler blocks 11 and 17.

After preparation of the core as just described it is slid onto face plate 3 so that the rows of fillers 11 contact the rows of fillers 12 on the face plate and the core is secured to plate 3 by welding the two sets of fillers to each other. The panel is now ready for complete assembly by sliding face plate 2 onto face plate 3 and when this is done the key members 16 secured to the already mounted core are engaged by the keyways of the clip members so that the two plates are firmly secured and keyed together. Screws or other fastenings 6 are then placed in the sides of the bulkhead to engage the bent portions 4 and 5 of the face plates in order to lock and hold them against relative movement with respect to each other and the ends 7 and 8 of the face plates are turned over to provide top and bottom closures for the bulkhead.

In construction of the core the insulant employed in any one of the micaeous minerals which are hydrous silicates known as vermiculite. It will be understood that similar minerals containing mica and silica and possessing similar qualities may be employed if desired. Expanded fines of the vermiculite which are in granular form are employed. This material is non-combustible, a poor heat conductor, will not break down at relatively high temperatures and hence provides an excellent fire proofing agent or insulant. The vermiculite is applied to each side of the core sheet in separate operations. A side of the corrugated core sheet is coated with silicate of soda and the insulant is thrown or blown against it until it is evenly spread over the entire surface of the sheet to the thickness desired, or the insulant may be built up in sections to form a single layer instead of applying it as just noted. Where such latter practice is followed a side of the core sheet is coated with the silicate of soda and the vermiculite is applied evenly over the entire surface to form a thin sub-layer of insulant. When the first sub-layer is dry, which occurs rapidly due to the characteristics of the silicate of soda, its surface is coated with the silicate and a thin but evenly spread second sub-layer of insulant is built on the first. This procedure is repeated until there are enough sub-layers to form a complete layer of vermiculite of the desired thickness.

Again with reference to the layer of vermiculite 19 on the inner sides of the face plates, this may be attached in a manner like that just described for securing the insulant to the core, while the asbestos sheeting 18 may be cemented to layer 19 with silicate of soda or other suitable adhesive.

Mentioned as one of the objects of the invention was the provision of means for joining or splicing several single wall, bulkhead or panel sections together to form an enlarged unit. Shown in Figures 6 through 8 are two forms of such splices or joints associated with panel sections having a fire resistant core like that already described and also with panel sections having a modified form of core construction.

Figure 9 discloses a front view of a bulkhead unit of three single sections and may be considered as representing and showing a front elevation of any of the units disclosed in Figures 6 through 8. The unit of Figure 9 consists of the jointed sections 20, 21, and 22. By way of illustration we have shown the bulkhead unit of Figure 9 of two equally wide end sections and an intermediate narrow section for the purpose of illustrating that the joint construction permits the splicing together of sections having either different or equal widths. The only limitation in the width of a section for a wall unit, is as already noted, determined by the width of sheet metal obtainable for face plates.

In size the unit of Figure 9 is approximately eight feet square. Such dimensions provide a multi-section unit which may be relatively easily handled during construction, assembly, shipment and erection in the field. However, it will be understood that the height of the unit may be varied as desired to fit the requirements of the particular wall it is to form and also that additional sections may be joined to the unit to increase its length or the unit may be constructed of only two sections.

With reference to Figure 6, there is shown a wall or bulkhead unit of three sections, the outer or end sections being constructed of the sheet metal face plates 26 and 27 and the center or intermediate section of the sheet metal face plates 28 and 29. Face plates 26 and 27 have their outer sides bent at right angles to the bodies of the face plates to provide the sides or edges 30 and 31 of the plates and the bulkhead unit, and while not shown, these plates and the plates 28 and 29 have their ends or one end only on each plate bent over to provide top and bottom closures for the unit.

At the inner or adjacent sides of the face plates 26 and 27 there is formed the female part of the splice connection used. This part of the joint is formed by bending the inner sides of the plates 26 and 27 parallel to the sides of the bulkhead unit to form one leg 32 of the U shaped channels shown, then turning the sides over upon themselves to complete the U and provide the legs 33 after which each side is bent parallel to the face of each sheet to provide a fastening or securing arm 34 for the joint. It will be noted that the legs 33 of the female part of the joint are shorter than legs 32. This permits the arms 34 to be positioned on the inner faces of the face plates 28 and 29 of the center bulkhead section so that the sections may be secured to each other. When assembled, suitable fastenings such as the rows of screws 35 through the sides of the sections are employed for securing together sides 30 and 31 of each outer bulkhead section.

On the intermediate bulkhead sections are formed the male members of the joint connection. The sides of face plates 28 and 29 are bent at right angles to the faces of the plates and inwardly towards the transverse or horizontal axis of the bulkhead unit to provide tongues 36. Tongues 36 are of a length substantially equal to the depth of each U formed for the joint connections on the outer bulkhead sections and are adapted to be engaged by the legs 32 and 33 of each U when the panel is assembled. To lock the joint, when it is made, and hence secure the sections together, rows of screws 37 extending from the top to the bottom of the bulkhead unit are employed for engaging face

plates 28 and 29 with face plates 26 and 27 through the locking arms 34 on the latter.

Similarly, as in the structure shown in Figures 1 through 5 the multi-section bulkhead unit is provided with a fire resistant core. In this instance, however, the core for each section is formed of two metal corrugated sheets 38 and 39 between which is placed the fire proofing material or insulant 40. As may be noted the several sheets forming each core facing are spliced to each other. The height of the fire resistant core is such that it extends from the top to the bottom of the bulkhead unit and when mounted therein is positioned so that the corrugations of the facings run in a vertical direction.

The spliced fire resistant core of Figure 6 is mounted within the bulkhead unit in much the same manner as the core disclosed in connection with Figures 1 through 5. For mounting the core, a plurality of metal filler blocks 14, spaced at equal distances apart in rows parallel to the longitudinal axis of the face plates, are welded to face plates 26, 27, 28 and 29. These rows of fillers extend from the bottom to the top of the face plates. Onto each row of filler blocks there is welded a metal clip member 15 which as already described forms a keyway for a metal key member 16. In this construction the key members 16 are welded directly to the corrugated sheets of the core along the crown or summit of every third corrugation of both core facings, while the rows of fillers and the key members on the face plates are positioned so that they will be directly opposite the key members and will engage them when the bulkhead sections are assembled. Fastening of the core occurs on both sides thereof, the securing units on opposite sides of the core being staggered with respect to each other. Both the key and the clip members are of a length substantially equal to that of the core. Although the fastenings formed of the clip and key members have been described as spaced along every third corrugation of the core it will be appreciated that this spacing may be varied as desired without departing from the spirit of the invention or exceeding the scope of the appended claims.

Asbestos sheets 18 and vermiculite 19 make up an insulating lining such as that already described for the inner side of each face plate. The layers of lining are suitably cemented to the plates. The filler blocks on the face plates are, as heretofore mentioned, employed to compensate for the thickness of the insulant cemented thereto, and for the same purpose, use is made of filler plates 41 placed between the face plates 28 and 29 and the arms 34 of the face plates 26 and 27. These filler plates 41 extend from top to bottom of the bulkhead unit.

Considering the core construction, one full length core facing with key members welded thereto is prepared and the insulant is applied to its inner side after which the corrugated sheets forming the other and opposite facing are placed on the surface of the insulant and the core is completed by securing the facings and the insulant together with suitable screws. Since it is impossible to obtain corrugated sheets equal in width to the bulkhead unit it is necessary to splice several of them together to form the core facings. The facing formed of the sheets 39, to which key members 15 have been attached, is prepared by laying out separate corrugated sheets so that their adjacent ends overlap and provide the overlapping portions 42. Sufficient sheets 39 are employed to provide the correct core width. If desired and to facilitate handling as a unit after the full width core facing is laid out the adjoining sheets 39 may be spot welded at intervals along their overlaps 42. To aid the insulant to cling to the facing, just described, small holes (not shown on the drawings) are bored at various intervals therethrough.

The insulant is now applied to the facing by evenly distributing it over the entire surface thereof to the thickness desired and is then allowed to dry. When the insulant on plates 39 is thoroughly dry, corrugated sheets 38, to which have been attached key members 16, are laid on its surface. Sheets 38 are so positioned as to provide overlaps 42 such as those already described for the opposite facing. These overlaps form the means for splicing the corrugated sheets together. The splices, facings and the insulant are now tied together by means of metal screws 43 driven through the completed core from both sides thereof as is disclosed in Figure 6.

Assembly of the multi-section bulkhead is similar to that of the single section wall. The face plates 27 and 29 having had the insulant lining 18 and 19 and clip members attached thereto may be laid out, with their outer surfaces upward, on a suitable work table and slid together, the tongues 36 on plate 29 being received and engaged by the legs of the U shaped joint members formed on the face plates 27. Screws 37 are engaged with the face plates so as to completely secure the splice between the different sets of plates. After this the assembled three section face plate is turned over and the completed core, prepared in the manner already described is slid into position and keyed to the clip members on the face plates and may be welded in position. The top and bottom closures for the unit are now formed by turning over the ends of the face plates.

Each of the sections of the face plates 26 and 28 having been completed, with insulating liner and clip members attached thereto, they are now slid over the assembled face plate sections and the core. The clip members on these plates engage the key members on the core opposite to the already assembled face plate sections and the joint and splice connection between the plates 26 and 28 is made. Screws 37 are now driven in to secure the splice while screws 35 are placed in their threaded holes to lock the sides of the unit together.

The insulant 40 employed in the construction of Figure 6 is a mixture of vermiculite, gypsum plaster and asbestos. This mixture is composed of 1 pound of vermiculite expanded fines to 3 pounds of gypsum hardwall plaster. To every hundred pounds of this mixture there is added from 2 to 3 pounds of asbestos short leaf fibre. Water is added to the mixture until with agitation it becomes a workable plastic mass when it is then applied to the corrugated core sheets. After even application on the core sheets, it is allowed to dry. This may be facilitated by placing the core sheets with the insulant within a drying oven. The insulant should be dried slowly for from 12 to 24 hours at a temperature range of from 100° to 120° F. While we have described the use of vermiculite it will be appreciated that similar minerals containing mica and silica may be employed, with equally effective results. Also other suitable plastic materials besides gypsum plaster may be used. Likewise

it will be well understood by those skilled in the art that the invention comprehends, that wide variation of the proportions of the mix for the insulant may be made without exceeding the scope of the invention.

In disclosing a three section unit it has been mentioned that this size facilitates handling and erection in the field. To such units additional units are usually secured in the erection of a fire wall or bulkhead. If desired instead of closing both sides of the bulkhead unit of Figure 6 one side may be left open. In following such practice the face plates 26 and 27 on the open side have either U shaped joint members or tongues 36 formed thereon instead of the overturned side portions 30 and 31 while the sheets 38 and 39 are extended a sufficient distance to provide overlaps 42 for the core of an adjoining unit. No insulant is placed between the extended overlaps. The bulkhead unit to which that just described is to be joined is similarly constructed with an open side having a male or female joint member formed on each face plate at the open side but does not have the extended core. For field erection the several sections may be laid adjacent each other and joined together by engaging the overlaps on one section with the core of the other section and fastening the bulkhead units together by engaging and securing the joint members on the end of each section to each other. Of course with such practice any number of wall units may be so constructed and tied together when erected in the field.

The invention as already pointed out comprehends several forms of splice or union for the sections of the multi-section bulkhead, a modified form of splice means being shown in Figure 7. In that figure there is disclosed a bulkhead unit, the sections thereof being formed of the face plates 44, 45, 46 and 47 between which plates is mounted a fire resistant core, such as that shown in Figure 6, formed of the metal corrugated sheets 38 and 39 enclosing insulant 40. As in construction of Figure 6, these sheets are spliced together with the overlaps 42 and are secured to each other through means of the metal screws 43 driven through both sides of the core. Likewise, in the manner heretofore described, the corrugated core of Figure 7 is securely mounted within the face plates of the bulkhead through the means of the filler blocks 14 welded to the face plates and clip members 15, and their key members 16 welded directly to the surface of the core facings. Each face plate is lined with asbestos sheeting 18 secured to a layer of vermiculite 19.

On one face of the multi-section bulkhead of Figure 7 the joint connections for the several sections are the same as described in connection with Figure 6 as may be observed from inspection of the drawings. Assuming a bulkhead of three sections having each end section made up of face plates 46 and 47 it may be noted that the face plate 47, is provided with the U shaped joint connection having legs 32, 33 and securing arm 34. The opposite end section of the bulkhead unit while not shown in the drawings is provided with a similar U shaped joint connection. A tongue 36 adapted to be engaged between the legs of the U shaped part of the joint connection on the end sections is constructed on the face plate 45 of the intermediate section.

The face plates 44 and 46, opposite to those just described are provided with female joint members only and are connected with splice plates 48 which latter are relatively narrow channels formed of sheet metal having the same thickness as that making up the face plates. These splice plates are of a length sufficient to extend from the top to the bottom of the unit and have their legs 49 engaged between the legs 32 and 33 of the U shaped joint connections. The joint with the splice plates is completed by means of screws 50 which secure each plate 48 to the arms 34 of the joint connection on the face plates of adjoining bulkhead sections. An asbestos and vermiculite liner is cemented to the web of each splice plate and in the manner already detailed filler plates 41 are employed between the arms 34 of the joint members and the web of the splice plate to compensate for the thickness of the liner.

Assembly of the unit just described is similar to the procedure used in completing the bulkhead unit shown in Figure 6. The face plates 45 and 47 are connected and secured to each other and the completed fire resistant core is mounted on them. After this a face plate 46 of an end section and the face plate 44 of the adjacent intermediate section are slid into position and keyed to the core. A splice plate 48 is then engaged with the legs of joint members on the adjacent face plates by also sliding it into position. Following the union the splice plate is fastened to secure the joint with the screws 50. The face plates 44 of additional intermediate sections of the bulkhead and/or the face plate of the other end section are then mounted in the manner just pointed out. Assembly of the bulkhead unit is completed by securing the overlapping sides with screws and by turning over the ends of the face plates to form the top and bottom closures for the unit.

In Figure 8 the fire resistant core constructed of a single corrugated sheet with insulant cemented to each side thereof is shown mounted within a multi-section bulkhead employing the splice plate construction, heretofore detailed in connection with Figure 7. The core is made to the desired width by using several corrugated sheets 9 which are spliced together. Each splice is effected by overlapping adjacent sheets 9 as indicated at 51 and securing these overlaps together with screws 52. Insulant 10 is then applied to the completed core as previously described in regard to the single section bulkhead of Figure 1 through 5. The bulkhead unit is assembled by following procedure like that employed for completing the unit of Figure 7 and the manner of carrying it out will be obvious from an inspection of the drawings.

Fire walls, bulkheads and panels such as those forming the subject matter of this invention may be erected against vertical base walls or may be used solely by themselves to form vertical walls or partitions and can be employed for ceilings. In whatever manner the panels may be used, their function is to delay the spread of any fire which might occur adjacent to the wall surface they form by retarding the passage of heat through such surface and localizing the fire until it can be controlled or extinguished. A suitable erection system, not forming a part of this invention and making use of various fittings, hardware and construction elements, is employed in the installation of the bulkheads and panels in their erected positions. Primarily, the fire safety structures disclosed in the drawings are employed for marine use for providing fire bulkheads for ships. However, it will be fully appreciated that they may be employed in housing construction as well and also

that it is within the scope of the invention to utilize these structures as fire doors.

From the foregoing description it will be realized that we have provided a fire wall, bulkhead or panel which possesses those features of good design required by sound engineering principles. The steel sheeting and insulants forming the parts of the bulkheads are incombustible materials which will not fail or disintegrate under the heat generated by a fire. Moreover the properties of these materials are such that they will withstand, without cracking and rupturing, the force and the cooling effects of liquid pumped against the completed structure.

A low unit weight for the bulkheads has been noted as a most important requirement of design. While all of the structures disclosed in the drawings are formed entirely of sheet metal and insulating materials it will be observed that the requirement of low unit weight is obtained when it is considered that the bulkhead of Figures 1 through 5 weighs 4.9 pounds per square foot of surface area and the wall shown in Figure 6 has a unit weight of 6.2 pounds per square foot. Both of these figures have included therein the weight of hardware (channel irons capping the top and bottom of the bulkheads) employed for mounting the structures for fire tests. While still maintaining a high safety factor this weight may be reduced by fifteen or more per cent by such construction expedients as decreasing the thickness of the fire insulant and by having only one top and bottom closure portion formed on the face plates. For example, by following such practices the weight of the single section bulkhead may be reduced from 4.9 pounds to 4 pounds or even less per square foot.

That the structures of the invention possess the important ability to prevent and retard the transmission heat through them while maintaining their structural integrity is shown by their capability to meet rigid standard fire tests. For example, the walls shown in Figures 1 through 6 have undergone tests wherein the tested bulkhead is mounted in the open side of a testing furnace so that one face thereof is exposed to the heat of the furnace fire and the other face, called the unexposed face or side, is open or exposed to the atmosphere of the room in which the test furnace is located. Under the standard test conditions, the furnace temperature is built up, reaching 1000° F. at the end of 5 minutes, 1300° F. at the end of 10 minutes, 1550° F. at the end of 30 minutes, and 1700° F. at the end of one hour. At the end of an hour the heating is arrested the bulkhead is removed from the test furnace and is torn down for inspection.

The passing requirements are that the structure or bulkhead must maintain its structural integrity for half an hour with no passage of flame through it, that no holes occur in the bulkhead and that there be no collapse of all or any part of the bulkhead. Also the inner core must be incombustible. In addition, the bulkhead must possess a fire resistance of not less than 15 minutes based on an average temperature rise of 250° F. above the initial temperature on the unexposed surface or a rise of 325° F. above the initial temperature at any one point on the unexposed surface.

Under the above test conditions the bulkheads of Figures 1 through 6 maintained their structural integrity. The tests showed that flexible yet strong constructions, capable of withstanding expansion, strains, and stresses caused by exposure of the bulkheads to fire have been provided. The bulkheads of Figures 1 through 6 when subjected to the test, just outlined, maintained their structural integrity for the whole test period of one hour, which it may be noted is 30 minutes longer than that required. While some deflection of the exposed side of the bulkhead towards the fire occurred during test, the structures again resumed substantially their original shape on cooling after test. Tearing down of the bulkheads when cooled revealed the absence of rupture or the shearing off of any parts of fastenings due to expansion and contraction strains and stresses. Also after testing for the time noted the union of the sections through the joint construction described remained in a tightly secured condition. Obviously contraction strains and stresses created due to sudden cooling would likewise be safely taken care of in the construction shown. By reason of the materials forming them, the cores of the tested panels met the test requisite of incombustibility.

As to the ability of the structures of the invention to prevent the passage of heat through them and hence the spread of fire, the tests showed that the single section bulkhead of Figures 1 through 5 maintained an average temperature on its unexposed surface of not more than 250° F. for 18 minutes, while the bulkhead of Figure 6 held these test requirements for 27½ minutes. To be noted is the fact that in all cases the bulkheads forming the subject matter of the invention exceeded the time safety factor set by the fire test, in one instance for 3 minutes and in the other instance for 12½ minutes.

By way of recapitulation it will be appreciated that we have disclosed novel fire resistant structures which by reason of the construction features employed and the proper selection of construction materials possess those qualities already noted as required by good design.

While we have shown and described the preferred embodiment of our invention, we wish it to be understood that we do not confine ourselves to the precise details of construction herein set forth, by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

We claim:

1. A fire wall comprising two spaced apart face plates, fire insulating and sound deadening material secured to a face of each of said plates, a fire resistant core formed of a corrugated sheet with fire insulant on the faces thereof, a plurality of clip members forming keyways secured to a face of one of said plates for engaging key members secured to a face of said core and keying said plate and core to each other, and a plurality of filler blocks secured to the other face of the core and to a face of the second face plate for mounting the core on said second face plate, said mounted core and face plates being secured against movement with respect to each other.

2. In a fire wall formed of a plurality of separate wall sections joined to each other to provide a multi-section unit, a set of face plates for each section, a fire resistant core formed of a set of corrugated face sheets with fire insulant therebetween, means for mounting said core between said face plates, said mounting means including clip members forming keyways secured to the inner surfaces of the face plates and key members secured along the crests of corrugations on both

faces of said core, the clip members engaging the key members to key the core in its mounted position and other means for joining the several sections together comprising female joint members formed on the face plates of alternate sections beginning with a section forming an end of the wall for engaging male joint members formed on the face plates of each wall section between said alternate sections, the joined sections being fastened to each other, and the mounted core and face plates being secured against relative movement with respect to each other.

3. In a fire wall formed of a plurality of separate wall sections joined to each other to provide a multi-section unit, a set of face plates for each section, a fire resistant core formed of a set of corrugated face sheets with fire insulant therebetween, means for mounting said core between said face plates, said means comprising clip members forming keyways secured to the inner surfaces of said face plates and key members secured to the face sheets of said core along the crests of corrugations thereof, the clip members engaging the key members to key the core in its mounted position and other means for joining the several sections together comprising male and female joint members formed on the face plates and separate splice plates with male joint members thereon, the face plates forming one face of the wall having the alternate plates thereof beginning with a plate forming an end of the wall formed with female joint members for engaging male joint members formed on the face plates between said alternate plates and the face plates forming the other face of the wall having only female joint members formed thereon for engaging male joint members formed on said separate splice plates, the joined sections being fastened to each other, and the mounted core and face plates being secured against relative movement with respect to each other.

4. In a fire wall formed of a plurality of separate wall sections joined to each other to provide a multi-section unit, spaced apart face plates forming each section, a fire resistant core formed of a plurality of corrugated sheets joined together to form a single sheet and having fire insulant on the faces thereof, means for mounting said core between said face plates comprising a plurality of clip members forming keyways secured to the face plates of one face of the unit for engaging key members secured to a face of said core and keying said plates and core to each other, and a plurality of filler blocks secured to the other face of the core and to the face plates forming the other face of the unit for mounting the core thereon, and other means for joining the several sections together comprising male and female joint members formed on the face plates and separate splice plates with male joint members formed thereon, the face plates forming one face of the wall having the alternate plates thereof beginning with a plate forming an end of the wall formed with female joint members for engaging male joint members formed on the face plates between said alternate plates and the face plates forming the other face of the wall having only female joint members formed thereon for engaging male joint members formed on said separate splice plates, the joined sections being fastened to each other, and the mounted core and face plates being secured against relative movement with respect to each other.

5. In a structure formed of spaced apart face plates between which a corrugated intermediate member is mounted, means for mounting said intermediate member between said face plates comprising clip members substantially equal in length to the length of the face plates and provided with overturned sides to form keyways secured to a face plate for engaging key members secured along the crests of corrugations of the intermediate member and of length equal to the clip members and key the intermediate member in its mounted position.

6. In a structure formed of a plurality of separate sections made up of spaced apart face plates, the sections being joined to each other to form a multi-section unit, means for joining the several sections together comprising female joint members formed on the face plates of alternate sections beginning with an end section of the structure for engaging male joint members formed on the face plates of each section between said alternate sections, each female joint member being formed on a face plate by turning over a side of the face plate at right angles to its body, then turning the side over upon itself to provide the legs of a U and then turning the side parallel to the body of the face plate to provide a securing arm, each male joint member on the face plates being formed by turning over a side of a plate at right angles to its body to provide a tongue, the joined sections being secured to each other with fastening members engaging the connecting joints of the sections.

7. In a structure formed of a plurality of separate sections made up of spaced apart face plates, the sections being joined to each other to provide a multi-section unit, means for joining the several sections together comprising male and female joint members formed on the face plates and a plurality of separate splice plates with male joint members thereon, the face plates forming one face of the structure having the alternate plates thereof beginning with a plate forming an end of the structure formed with female joint members for engaging male joint members formed on each face plate between said alternate face plates and the face plates forming the other face of the structure having only female joint members formed thereon for engaging male joint members formed on the separate splice plates, each female joint member being formed on a face plate by turning over a side thereof at right angles to the body of the plate, then turning the side over upon itself to provide the second leg of a U and then turning the side parallel to the body of the plate to form a securing arm, the male joint members on each face plate and splice plate being formed by turning over a side of the plate at right angles to its body to provide a tongue, the joined sections being secured to each other with fastening members engaging the connecting joints of the sections.

8. A fire wall comprising spaced apart face plates forming the wall surfaces, a fire resistant core member of substantially the same length and width as said fire wall mounted between the inner faces of said wall surfaces, and clip members secured to the inner face of a wall surface for engaging key members secured to the face of the core opposite to said wall surface and keying the core in mounted position, said mounted core and face plates being secured against relative movement with respect to each other.

9. A fire wall comprising spaced apart face plates forming the wall surfaces, a corrugated fire resistant core member mounted between the inner faces of said wall surfaces, and clip members

secured to the inner face of a wall surface for engaging key members secured along the crests of corrugations on the face of the core member opposite said wall surface and keying the core member in mounted position, the mounted core and face plates forming the wall surfaces being secured against relative movement with respect to each other.

10. A fire wall comprising spaced apart face plates, a fire resistant corrugated core sheet, a plurality of clip members forming keyways secured to a face of one of said plates for engaging key members secured along the crests of corrugations on the face of said core sheet and keying said plate and core sheet to each other, and a plurality of filler blocks secured to the other face of said core sheet along the crests of corrugations thereon and to a face of the other face plate for mounting the core on said second plate, said mounted core and face plates being secured against movement with respect to each other.

11. A fire wall comprising spaced apart face plates, fire insulating and sound deadening material secured to a face of each of said plates, a fire resistant core formed of a corrugated sheet with fire insulant on the faces thereof, a plurality of clip members of a length substantially equal to that of a face plate and provided with overturned sides to form keyways secured to a face of one of said plates for engaging flat strips forming key members secured to a face of said core along crests of corrugations thereof and keying said plate and core together, said key members being of a length equal to that of the clip members, and a plurality of rows of filler blocks secured to the other face of the core along the crests of corrugations thereof and to a face of the other face plate for mounting the core on the second plate, said rows of filler blocks being parallel and opposite to each other, and the mounted core and face plates being secured against movement with respect to each other.

12. In a fire wall formed of a plurality of separate wall sections joined to each other to form a multi-section unit, spaced apart face plates forming the wall surfaces of each section and the surfaces of the entire wall when said sections are joined together, engaging male and female joint members provided for the face plates for joining the sections to each other, said sections being secured to each other after being joined, a fire resistant core member of substantially the same length and width as said fire wall mounted between the face plates forming the surfaces of said wall, and clip members secured to the inner face of a wall surface for engaging key members secured to the face of the core member opposite thereto and keying the core member in mounted position, the mounted core member and face plates being secured against relative movement with respect to each other.

13. In a fire wall formed of a plurality of separate wall sections joined to each other to form a multi-section unit, spaced apart face plates forming the wall surfaces of each section and the surfaces of the entire wall when said sections are joined together, engaging male and female joint members provided for the face plates for joining the sections together, said sections being secured to each other after being joined, a corrugated fire resistant core member mounted between the inner faces of the wall surfaces, and clip members secured to the inner face of a wall surface for engaging key members secured along the crests of corrugations on the face of the core member opposite said wall surface and keying the core member in its mounted position, the mounted core and face plates forming the wall surfaces being secured against movement with respect to each other.

14. A fire wall comprising spaced apart face plates forming the wall surfaces, a corrugated fire resistant core member mounted between the inner faces of said wall surfaces, and a plurality of clip members of a length substantially equal to that of a face plate and provided with overturned sides to form keyways secured to the inner face of a wall surface for engaging flat strips forming key members secured along the crests of corrugations on the face of the core member opposite said wall surface and keying the core member in mounted position, said key members being of a length equal to that of the clip members, the mounted core and face plates forming the wall surfaces being secured against relative movement with respect to each other.

15. In a fire wall formed of a plurality of separate wall sections joined to each other to form a multi-section unit, spaced apart face plates forming the wall surfaces of each section and the surfaces of the entire wall when said sections are joined together, engaging male and female joint members provided for the face plates for joining the sections together, said sections being secured to each other after being joined, a corrugated fire resistant core member mounted between the inner faces of the wall surfaces, and a plurality of clip members of a length substantially equal to that of a face plate and provided with overturned sides to form keyways secured to the inner face of a wall surface for engaging flat strips forming key members secured along the crests of corrugations on the face of the core member opposite said wall surface and keying the core member in its mounted position, said key members being of a length equal to that of said clip members, the mounted core and face plates forming the wall surfaces being secured against relative movement with respect to each other.

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