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PLASTIC ROLLAWAY DOOR

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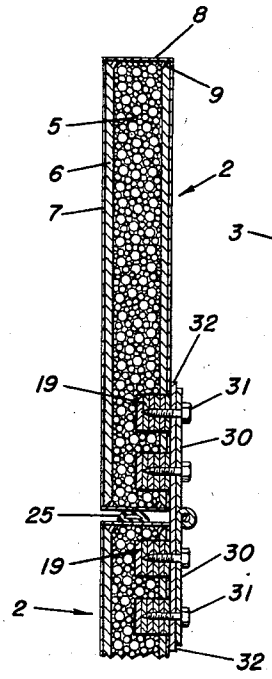


Fig. 4

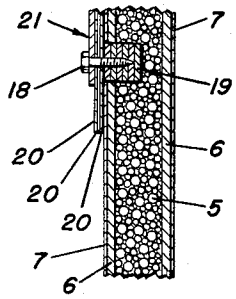


Fig. 3

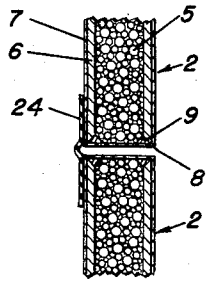


Fig. 6

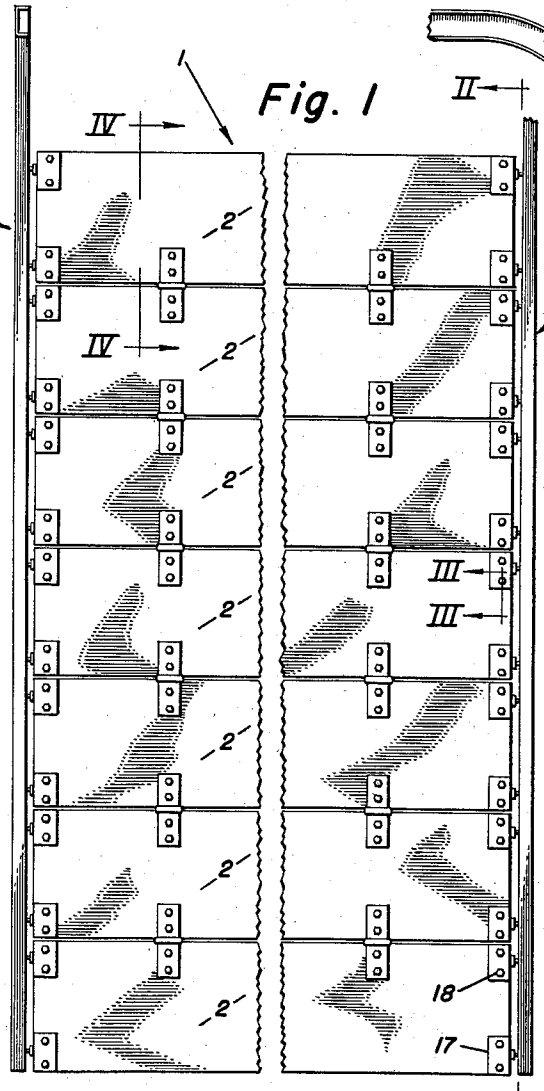


Fig. 1

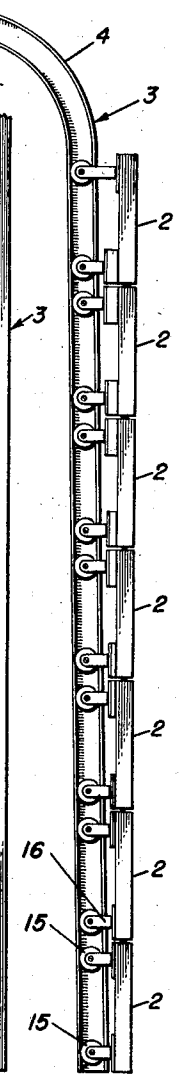


Fig. 2

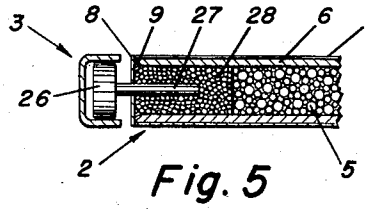


Fig. 5

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PLASTIC ROLLAWAY DOOR

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4 Claims. (Cl. 160—40)

This invention relates to sectional doors of the type adapted to move along a track from a vertical, closed position to an overhead horizontal storage position and more particularly to such doors fabricated of synthetic resins.

This application is a continuation-in-part of our copending application Serial No. 484,948, entitled Improvement in Enclosures for Refrigerated Areas, filed January 31, 1955.

While the overhead, sectional door consisting of a plurality of individual panels, each of which moves along a track, is well-known, this invention provides several improvements in this type of door.

Such doors, when manufactured of conventional materials, if they are of any size, are exceedingly heavy and thus require either substantial counterbalancing or they are too difficult to manipulate. The lightweight of the materials of this invention greatly relieves this difficulty.

Prior to this invention, thermal insulating doors of this type were impractical because the type of construction required to provide effective insulation made the doors too heavy to be operated.

It is also important that each door panel remain straight since even slight warpage frequently results in binding between the panels themselves and sometimes between the panels and the track. It also results in misalignment of the panels at their joints. The latter will prevent proper seating of the panels against each other and may permit leakage between them.

This invention is designed to eliminate this problem by providing individual panels which are dimensionally stable and are not subject to warpage even under the most extreme moisture conditions. This assures proper alignment of the panels at all times, both with each other and with the track.

This invention further provides doors of exceedingly lightweight even though the door area is of substantial size.

This invention accomplishes these purposes while providing a strong, puncture resistant panel, capable of withstanding severe operating conditions. The panel is both rigid and highly resistant to other mechanical injury.

This invention provides door panels which are impervious to moisture and, therefore, are not adversely affected by extreme climatic exposure in either hot or cold climates. The panels are both rot and vermin proof. The maintenance of the panel is reduced to a minimum since their natural structure eliminates the necessity for such frequent maintenance expenditures as annual painting. Corrosion and paint peeling are also eliminated. These and other objects and purposes of this invention will be immediately seen by those acquainted with the design and construction of overhead, rollaway, sectional doors upon reading the following specification and the accompanying drawings.

In the drawings:

Fig. 1 is an inside, elevation view of a rollaway, overhead, sectional door constructed according to this invention.

Fig. 2 is a side elevation view of the door shown in Fig. 1.

Fig. 3 is an enlarged, sectional view of a typical hardware attachment to one of the panels taken along the plane III—III of Fig. 1.

Fig. 4 is an enlarged, sectional, elevation view taken along the plane IV—IV of Fig. 1.

Fig. 5 is an enlarged, sectional view of a modified mounting for the door supporting hardware.

Fig. 6 is a fragmentary, side elevation view of a means of sealing the joints between the door panels.

In executing the objects and purposes of this invention, there is provided a door consisting of a plurality of individual panels. Each of the panels has suitable hardware installed on it to engage a supporting track. The track is so shaped that as the door is moved upwardly, the panels, one by one, rotate from a vertical to a horizontal position and are stored collectively on the horizontal upper portion of the track in an overhead position. The arrangement of a door and a track to effect this purpose is conventional.

Each individual door panel has a core of low density, cellular, synthetic resin. This core is entirely enclosed by a high density, woven fiber glass, reinforced, synthetic resin facing sheet. On the two large faces of the panel, this facing sheet is underlaid by a rigid sublamina of a suitable, puncture resisting material such as plywood. The combined thicknesses of the sublamina and the facing skins constitutes a minor portion of the total thickness of the panel. Where the doors have the hardware mounted on one face, suitable thread bearing plugs are installed in the door and adhesively bonded to the panels. Where the supporting hardware is mounted to the sides of the panel, the hardware is inserted through the side edge of the panel and is adhesively bonded to the core material over a sufficiently large area to properly distribute the operating loads.

Referring specifically to the drawings, the numeral 1 refers to a door having a plurality of panels 2. Each panel is a separate and individual element. The width of the panels 2 is determined by the width of the door opening. The height of each of the panels 2 is designed to be that which will readily permit the door to pass around the curve 4 at the upper end of the track (Fig. 4). Preferably, the panels have as great a height as will properly traverse the curve 4, since the fewer the panels the lower the cost of the door. Each of the panels 2 has a low density, foamed, synthetic resin core. This core material is cellular throughout. These cells must be of the closed type whereby communication between individual cells does not occur. This is necessary to prevent moisture migration and heat transmission through the panels. One such material is a foamed polystyrene such as that made by polymerizing a hydrocarbon or halo-hydrocarbon having a vinyl radical on an aromatic nucleus and including the products resulting from polymerization of styrene, monomethylstyrene and di-methylstyrene, vinyl naphthalene and a halogenated styrene. This type of foamed, core material has a normal density in the range of two to ten pounds per cubic foot. It is also possible to fabricate the core of a foamed in situ reaction product of a polyisocyanate and a suitable polyester or alkyd resinous composition. An example of such a polyisocyanate is a methyl-toluene-diisocyanate. Various other aromatic polyisocyanates can be employed quite satisfactorily. Certain other materials may be used for cores such as any of the several foamed phenolic resins. Various other resins may be expanded or foamed to produce a low density, closed cell structure suitable for use as a core material for these panels.

The core 5 is rigid and has a thickness depending upon the requirements of the door. The core 5 has flat, planar, parallel surfaces. A suitable thickness for the core of the average door not designed to enclose a refrigerated area is two inches. Where the door is designed for a refrigerated area, it will normally have a thickness ranging from 3 to 6 inches. The lightness of the material makes doors of this thickness both feasible and practical.

A rigid sublamina 6 is bonded to each of these surfaces. The sublaminae 6 are preferably about one-eighth inch thick. These should be of a tough, fibrous material. They may be of plywood or of a rigid, fibrous, composition panel such as the ligneous product sold as "Masonite" by the Masonite Corporation. The sublamina may also be of mineral fibers surrounded by a suitable binder. An example of such a material is "Flexboard," an asbestos fiber panel sold by Johns-Manville Corporation. It is important that this panel be rigid and puncture resistant. Preferably, the sublamina should also be of a non-brittle material readily bondable to the foamed, synthetic resin core. The addition of the polyester and filamentary glass facing provides substantial impact protection for brittle materials since it serves as a resilient shock distributing web.

To each of the outer faces of the sublamina 6 there is bonded a protective skin 7. The facing skins 7 are of a hard, dense, polyester, synthetic resin. The polyester is reinforced with a fibrous material such as a woven filamentary glass. The facing skins 7, when cured, have a normal thickness within the range of 0.015 to about 0.060 of an inch. Facing skins of this material are tough, hard, wear-resistant and moisture impervious. They are also impervious to attack by many chemicals with which they will come in contact in normal use. As such, these skins provide a tough, protective, outer surface for the panels. The presence of the woven glass reinforcement substantially improves the structural characteristics of the skin as tension carrying members. It also adds toughness to the skins, increasing their resistance to impact.

The sublaminae 6 are bonded to the core 5. The same adhesive may be used for bonding the facing skins 7 to the sublamina 6. This adhesive must be strong, water resistant and suitable for use both with polyester resins and with the synthetic resin of the core material 5. A suitable adhesive for this purpose is an epoxy resin adhesive hardenable at ambient or moderately elevated temperatures and under only sufficient pressure to assure firm contact between the laminae and the core during the curing period. This adhesive is a liquid, partially polymerized, high molecular weight, reaction product of a diphenol and an epoxy compound. One example of such a reaction product is that obtained by heating together 2,2'-bi (4-hydroxyphenyl propane) and epichlorhydrin in the presence of an alkali such as sodium hydroxide, whereby there are formed polymeric glycidyl polyethers of the phenolic substance having properties of an average molecular weight depending upon the reaction conditions and the proportions of the reactants employed. This is merely an example of one particular adhesive and it will be recognized that various other materials may be used without in any way affecting this invention.

Contact type adhesives may be used for bonding the various laminae of the panel. The contact resins used for this purpose must be of a type which will adhere strongly to themselves even after evaporation of the carrier, whether it is water or a solvent. The escape of the carrier presents a serious problem in these panels if joinder of the laminae is attempted before drying where the laminae are both vapor barriers. The absorbant character of wood and similar types of sublaminae will permit escape but the carriers will become trapped in the sublaminae to the detriment of the physical characteristics of the panels unless the quantities are quite limited.

A water emulsion type of contact adhesive should be used adjacent the core. Examples of such contact adhesives are EC–971, and Nos. 321, 871 and 971, all sold by Minnesota Mining and Manufacturing Co. A solvent carrier type of contact adhesive may be used to bond the facing skins to the sublaminae. Examples of such adhesives are D–253–20, sold by Armstrong Cork Company and EC–1390, sold by Minnesota Mining and Manufacturing Co. The former is a synthetic rubber base material containing approximately 20% solids by weight and a solvent including methyl-ethyl-ketone. The former includes a solvent of blended petroleum naphtha, toluol and methyl-ethyl-ketone. It also contains some phenolic resins.

It is also possible to use either urea or resorcinol based adhesives. These are useful for bonding the sublaminae to the polystyrene core. They have not been found to be satisfactory for bonding to the polyester facing sheets since an incomplete bond normally results. Further, the resulting bond lacks consistency of quality.

It is important that the adhesives develop a strength equal to that of the core so that there will be effective transmission of shear between the various laminae of the panel.

The edges of the panel 2 are enclosed by edging strips 8 which are identical in material to the facing skins 7. Like the facing skins, the edging strips 8 are adhesively bonded to the core using a suitable adhesive such as an epoxy resin type.

At each end of the edging strips 8, a pocket 9 is created partially in the core 5 and partially in the sublamina 6. The pockets 9 are each filled with an adhesive such as that described for attaching the edging strips 8 to the core 5. For this purpose, the epoxy resins should be rendered more viscous so that they will form a bead without unnecessary flow. The viscosity of epoxy resins may be increased by loading them with suitable bulking or extending materials. These materials are generally known as extenders and include, among others, calcium carbonate, magnesium silicate, aluminum silicate, silica and diatomaceous earth. While the extender may consist of one of these materials, it is more commonly a mixture of several. By controlling the quantity of the extender added to the resin, the viscosity of the resinous adhesive may be closely controlled. Preferably, it is given a consistency suitable for spreading as a paste-like substance or forced into the pocket under pressure.

The beads formed in the pockets 9 by the application of the viscous epoxy resins provide a firm bond directly from the edging strip 8 to the sublamina 6 and to the core 5. This bead provides a direct bond from the edging strip to the sublamina 6. The sublamina 6 is of a material having good strength in tension, a characteristic not true of the low density, foamed, synthetic resin, core materials. Consequently, the bead provides a positive anchor for the edging strips whereby tension applied to the strips, tending to peel them from the panel, will not produce separation, destroying the panel's edge protection.

Each of the panels is secured to the supporting track 3 by at least a pair of wheels 15 on each side, one adjacent the top and one adjacent the bottom of the panel. The wheels 15 are each mounted for free rotation upon the end of an arm 16. The arm, in turn, is secured to a plate 17. The plates 17 lie against the inside face of the panel and are secured to the panels by suitable fasteners, such as lag screws 18 (Figs. 1 and 3). Since the combined thickness of the sublamina and the facing sheet is insufficient to provide adequate thread bearing for the lag screws 18 and the core material is weak in tension, a bearing block 19 is inserted in the panel. The bearing block 19 may be of any suitable material of which the one illustrated is of plywood. To install the bearing

blocks 19, a circular opening is created in the panel through one face and partially through the core 5. This may be done in any suitable manner such as by drilling or coring. The walls of this opening are coated with a suitable adhesive. The bearing block is then inserted so that its top face is flush with the surface of the skin of the panel. Since all laminae of the panel are moisture impervious, it is immaterial whether moisture can enter through bearing blocks of a hygroscopic material. Migration of moisture will be effectively stopped at the walls of the opening seating the bearing block. However, if it is desired to entirely exclude moisture from the bearing blocks 19 for the protection of the blocks themselves, this may be done by adhesively bonding a pad 20 over the outer surface of the bearing block. This pad 20 may be of the same material as the facing skin.

Where the track 3 is inclined away from the door, as illustrated in Fig. 2, a slight divergence is created between the vertical position of the track and the door, the same hardware may be used if fillers 21 of progressively increasing thickness are mounted between the hardware and the door. These fillers 21 may be created by the use of one or more thicknesses of the pads 20 (Fig. 3). Also, the thickness of the individual pads may be selected to meet the requirements of the particular installation. The number of pads bonded together to provide the desired thickness will be dependent upon the total pad thickness required. The pads will be laminated together by the same adhesive as that used for bonding the facing skins 7 to the sublamina 6.

The panels 2 must be articulately joined so that they will travel along the track as a group. This is done by the use of hinges 30. As many hinges 30 are used across the door as are necessary. The hinges are attached by lags or screws 31 which thread into bearing blocks 19 embedded in and adhesively bonded to the panels (Fig. 4). Preferably, the bearing blocks 19 are covered by a pad 32 similar to the pads 21. The pads 32 underlie the entire hinge and are bonded to the panel facing skin by suitable adhesive. Sufficient hinges are applied at each joint to prevent excessive load concentration at any of the bearing blocks 19.

The individual panels 2 must be so arranged with respect to each other that when the door is in its vertical, closed position, the panels are slightly spaced apart to prevent binding when the panels traverse the curved portion of the track. This requires a suitable air seal at each joint. One particular type of air seal is illustrated in Fig. 4 in which a compressible gasket 25 is mounted on the edge of one of the panels 2 and is contacted and slightly compressed by the next adjacent panel when the door is closed.

Fig. 6 illustrates another method of accomplishing this same result. In this arrangement, a flexible sealing strip 24 of a suitable material such as rubber, is secured to the inside face of the panels 2 and bridges the gap between them. The sealing strip 24 must be flexible to permit it to bend and change its shape as the panels traverse the curve 4 at the top of the track 3. Any suitable adhesive may be used for bonding the sealing strip 24 to the panels 2 so long as it will effectively bond to the material of the sealing strip and to the facing skins of the panels without adversely affecting either.

While it is a more common arrangement to mount the supporting hardware on the inside faces of the panels 2, it is, under certain circumstances, desirable to mount this hardware to the edges of the panels. Such an arrangement is illustrated in Fig. 5. In this case, the track 3 is aligned with the door. The wheels 26 of the supporting hardware are seated in the track and are freely rotatable on a shaft 27. The shaft 27 is inserted through the edge of the panel a substantial distance into the panel's core.

To properly support the end of the shaft 27 in the area of the panel core, it is surrounded by a material of higher density than that of the core. This may be done in any of several ways. Where the shafts 27 are attached by threads, wooden plugs 19 may be embedded in and adhesively bonded to the core. Where the shaft is attached merely by adhesives, it may be surrounded by a high density foamed polystyrene having a density of 4½ or more pounds per cubic foot. This may be done in the form of plugs such as the plugs 19 or by substituting a strip 28 of high density foamed polystyrene at each vertical edge of the panel (Fig. 5).

To mount the shaft 27, a hole is bored or otherwise created through the edging strip 8 and the high density material, whether in the form of a strip or a plug. A suitable quantity of adhesive, preferably an epoxy resin adhesive which has had its viscosity increased by the addition of extenders such as that used to form the beads in the pockets 9, is placed in the hole and the shaft 27 inserted. Once this adhesive has set, the hardware is firmly affixed to the panel and will support the door as it is moved along the track.

Doors constructed pursuant to this invention operate in the same manner as doors of conventional design. However, the high strength to weight ratio and the dimensional stability of this material provides a door which is substantially easier to operate. The lightness of the door materially facilitates its manipulation. It also provides a door of greatly improved functional characteristics, eliminating the binding and other malfunctioning resulting from warpage or dimensional variation. The doors are resistant to weather since the only material capable of absorbing moisture is the sublamina 6. This sublamina 6 is completely protected by the moisture impervious core on one face and the moisture impervious facing skins 7 and edge band 8 on the other faces. Thus, the sublaminae are sealed from moisture and protected from exposure to adverse climatic conditions. Even in those areas where the plugs 19 are inserted, a moisture barrier is formed by the film of adhesive between the plug and the walls of the opening. This is particularly true where the adhesive is an epoxy resin.

The dimensional stability of the individual panels 2 assures continued, effective sealing between the individual panels and between the door and its surrounding frame. This result has not heretofore been accomplished with doors of this type. Doors manufactured of wood expand in damp weather and contract in dry weather. The substitution of metal for wood largely overcomes this problem but when such doors have sufficient thickness to overcome the danger of injury due to impact, they are excessively heavy. They are also subject to corrosion and rot. Being of vapor pervious materials, they tend to collect water, particularly when there is any appreciable temperature differential across their thickness. This also can add substantially to their weight. These heavy doors are difficult to operate and require substantial supporting structure.

These improvements in functional characteristics are obtained without loss of strength. The panels 2 are strong and resistant to puncture.

Based upon tests conducted with these panels having an overall thickness of 2¼ inches and including two 0.018ths of an inch thick facing sheets of polyester resin reinforced with one layer of woven fiber glass, a core of foamed polystyrene of two pounds per square foot density and interbands of sublaminae of 0.125th of an inch plywood, the following values were obtained:

Weight per square foot	pounds	16.4
Maximum bending moment	inch pounds	3,612
E.I	inch ^{2} pounds	734,301
Maximum shear	pounds	110.0
Ultimate uniformly distributed weight per square foot over a 10 foot span	pounds	264.0

In impact tests on this same panel conducted by dropping a sphere on the panel while the panel was lay-

ing on a cement floor, the following values were developed:

Sphere—Diameter in Inches	Impact in Foot Pounds	Identation in Inches
2	5	0.03
2	10	0.04
2	20	0.16
3	5	0.03
3	10	0.04
3	20	0.08

Ultimate impact with the 2 inch sphere was 22 foot pounds, leaving an indentation of 0.17 of an inch; with the 3 inch sphere it was 38 foot pounds, leaving an indentation of 0.21th of an inch. Accordingly, this invention provides a door of improved functional and structural characteristics.

A preferred embodiment of this invention together with several modifications thereof have been described and illustrated. It will be recognized that various changes may be made in the details of this construction without in any way departing from the principles thereof. Such modifications are to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

We claim:

1. A door construction comprising a plurality of elongated separate dimensionally stable panels, each of said panels having a rigid, low density, cellular, synthetic resin core, a dense, thin facing sheet bonded to each face of said core; said facing sheets being structurally tied together solely by said core; an edge band bonded to each edge of said core, said facing sheets and said edge bands each being of woven filamentary glass impregnated with a high density polyester synthetic resin, hinge means mounted on said facing sheets hingedly connecting the longitudinal edge portions of adjacent panels, a pair of guiding and supporting tracks disposed adjacent to the ends of said panels, means having a portion thereof embedded in each end portion of said panels movably mounting each of said panels to each said track.

2. A door construction comprising a plurality of separate dimensionally stable panels of generally rectangular shape, each of said panels having a rigid, low density core of expanded, cellular polystyrene having a density of two to four pounds per cubic foot, a facing sheet having a thickness of 0.018 to 0.40 of an inch bonded to each face of said core, said facing sheets being structurally tied together solely by said core said facing sheets being of a dense polyester synthetic resin having a woven filamentary glass fabric embedded therein, an edge band of the same material as said facing sheets bonded to each edge of said core, means pivotally connecting said panels together, said pivot means being attached to the surface of said facing sheets and lying substantially in the plane thereof, a guiding and supporting track, and means having a portion thereof embedded in the end portion of each said panel for movably mounting each of said panels to said track.

3. A door construction comprising a plurality of separate panels, each of said panels having a rigid, low density core of expanded, cellular polystyrene of a density of two to four pounds per cubic foot, a rigid, puncture resistant lamina adhesively bonded to each side surface of said core and a facing sheet having a thickness of 0.018 to 0.40 of an inch bonded to each face of said lamina, said facing sheets being of a dense polyester synthetic resin having a woven filamentary glass fabric enclosed therein, hinge means mounted on the adjacent edge portions of each pair of adjacent panels hingedly connecting adjacent panels to form a unitary door, an edge band of the same material as said facing sheets bonded to each edge of said core, track means extending along the end surfaces of said plurality of panels and disposed adjacent thereto, and means for movably mounting each of said panels to said track means, a portion of said mounting means being embedded in the end portion of each of said panels and adhesively bonded thereto, a supporting block of a material of higher density than that of said core surrounding the portion of each of said mounting means embedded in said end portions and said supporting block being adhesively bonded to said core.

4. A door construction in accordance with claim 3 wherein sealing means is mounted on at least one of said panels of a pair of said panels adjacent to each other effecting a seal therebetween at least during the time that each of said facing sheets lie in substantially the same plane.

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