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FIRE RESISTANT DOOR

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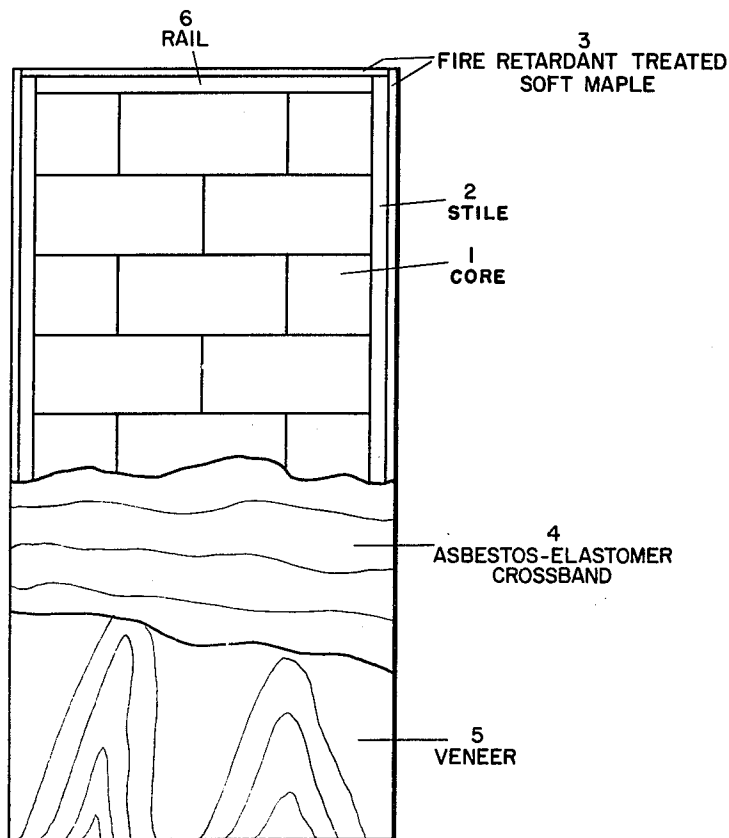
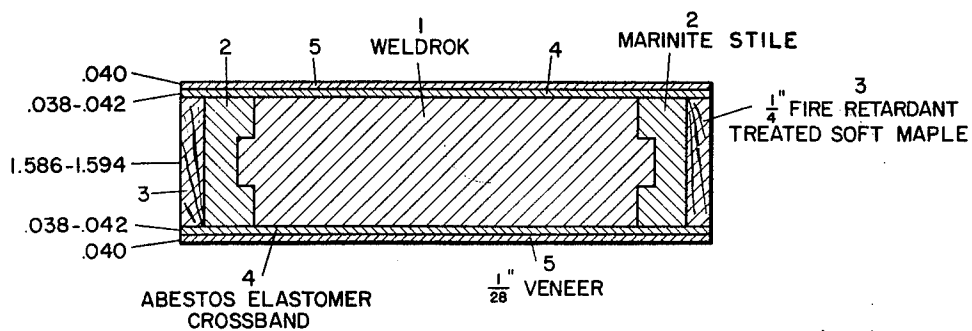


FIGURE 1

FIGURE 2



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FIRE RESISTANT DOOR

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5 Claims. (Cl. 20—15)

The present invention is broadly concerned with building construction units and is particularly directed toward an improved type of fire resistant composite door, panel or similar structure. Thus, one object of the present invention is to provide a structural unit such as a door or panel which is practically fireproof, by being highly resistant to the destructive action of fire and extremely high temperatures. The door or panel or equivalent unit of the present invention is composed of a plurality of different materials, each of which functions to raise the fire resistant characteristics of the unit as a whole to an extremely high level.

Another object of the present invention is to provide a composite door or panel of the type indicated which is highly resistant to leakage or the passage therethrough of hot gases, hot air, smoke or other vapors and which will not warp or bend when subjected to extremely high heat concentrated on one side of the door or panel. Other objects of the present invention are to provide a high type fireproof unit which is composed of materials which are of a very light weight and highly resistant to the transmission of heat therethrough.

In essence, the door or panel of the present invention comprises in combination a core, suitable stiles and rails, fire resistant cross bands comprising asbestos, fire resistant glue sheets and veneer facings.

The composite door or panel structure of the present invention is of such a nature that it will meet the Fire Underwriters Laboratory test described in ASTM E152-56T Underwriters Laboratory Inc. for Fire Tests of Door Assemblies Pamphlet U.L. 10(b) 3rd edition.

In essence, the test requires the door to pass the code requirement for a 1½ hour fire door test. In this test, the door must be capable of withstanding, for 1½ hours, flames which cause a buildup in the temperature to 1790° F., on one face of the door. The temperature rise on the opposite face of the door during the first one-half hour must not exceed 250° F. above ambient temperature. At the end of this fire exposure test, the door must withstand the impact of a water hose stream at 30 lbs. pressure, which water hose stream is played on the door from a distance of 20 feet for one minute and 47 seconds. As pointed out heretofore, the door or structure of the present invention is highly resistant to the leakage or transmission of high temperature heat which might ignite flammable materials which are located on the cold side of the structure.

It is to be noted that, at present, there exists no 1½ hour wood faced composite fire door. The only door which has a 1½ hour Underwriters label is a metal door. The composite door of the present invention is the first such door to pass the Underwriters test for a 1½ hour door. Thus, each component is interrelated and functions to produce a combined fire retardant 1½ hour composite fire door.

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The door structure of the present invention may be readily appreciated by reference to the figures illustrating one embodiment of the same. FIGURE 1 is a plan view of the door with the facing plies thereof broken away in order to show the construction. FIGURE 2 is a fragmentary cross-section view through the core and door.

Referring specifically to the figures, the core 1 of the door consists of a fireproof or non-burning inorganic material which has excellent heat insulating properties.

A particularly desirable material for the core is "Weldrok" which is sold by United States Plywood. In general, this material should have a density in the range from about 18 to 24 lbs./cu. ft., preferably having a density in the range from 20 to 24 lbs./cu. ft. A particularly preferred type of material for the core is a calcium silicate subhydrate which is rendered porous by certain manufacturing steps.

In essence, the core material "Weldrok" consists of an incombustible mineral material consisting of complex metal silicates with fiber binder. Density of the core material can range from 18 to 24 lbs./ft.³. Weight/sq. ft. of this core material is 4 lbs. Weldrok is warp free and stable, and possesses a U factor of approximately 0.35 B.t.u./hr./sq. ft./° F.

The structural frame comprising stiles 2 and rails 6 are inorganic materials marketed by Johns-Manville under the trade name "Marinite." Since these materials are inorganic in nature, this type of structural frame prevents any burnout around the core material. "Marinite" is composed of an asbestos fiber, diatomaceous silica and an inorganic binder.

A fire retardant element 3 preferably a hard wood such as maple or hinge and lock blocks, composed of Marinite or treated maple, is positioned along the rails 6 and stiles 2. The ¼" fire retardant treated soft maple lumber is treated by the vacuum pressure cell process.

The crossbands 4 contribute greatly to the basic fireproofing composition and nature of the door of the present invention. These crossbands are of an asbestos neoprene composition and contribute greatly to the effectiveness of the door. The faces 5 of the door comprise lignocellular material, preferably veneer, and are laminated to the crossbands 4 with a phenolic impregnated adhesive. A preferred type is a precatalyzed phenolic powdered resin HP-401D, made by the Borden Chemical Company. Another satisfactory adhesive is "Tego" sold by Rohm and Haas. Tego is a B stage phenolic impregnated adhesive sheet which will cure under heat.

The dimensions of the panel or door may be varied appreciably depending upon its ultimate use. These dimensions are interrelated and depend upon the size and unit being fabricated. One satisfactory unit is to have the core of a thickness of from 1.586" to 1.594". Under these conditions, the rails would approximate ¾" x 1.586" to 1.594" and the thickness of the crossband would approximate .038" to .042" thick.

One typical group of dimensions are given in FIGURE 2. It is to be noted that core 1 is keyed into stiles 2.

In order to further illustrate the invention, one technique for constructing the 1½ hour fire door is as follows:

(1) The core is made of Weldrok as manufactured by U.S. Plywood.

(2) The inner stiles and rails are made of Marinite—36 lbs. density, ½" wide.

(a) The Weldrok core and Marinite stiles and rails are sized with a catalyzed urea formaldehyde resin.

(3) Fire retardant treated lumber outer stiles and rails such as soft maple are 1/4" wide and are used adjacent to the inner members.

(4) The Weldrok core, inner Marinite stiles and rails and outer fire retardant treated wood stiles and rails are bonded together via the radio frequency bonding method.

(a) The adhesive can be either a catalyzed urea-formaldehyde resin reinforced with a precatalyzed phenolic powdered resin HP-401D or a phenol-resorcinol adhesive resin.

(5) After curing, this assembly is then sanded on both surfaces to a uniform thickness of approximately 1.586".

(6) The assembly is then sized with a phenolic resin sizing formulation and semi-precured under an infra-red oven. The phenolic resin is similar to that which is manufactured by the Borden Chemical Company.

(7) The asbestos elastomer crossband is then sized and also semi-precured in the same manner as the assembly.

The process fabrication steps for the unit are as follows:

(1) A veneer face is placed on a platform.

(2) The previously sized and semi-precured asbestos crossband has a phenolic adhesive applied to both surfaces which is then flashed off and semi-precured under an infra-red oven. After immediate cooling, it is placed on the veneer face.

(3) The previously sized unit or core is then applied to the other surface of the semi-precured asbestos material.

(4) The second asbestos crossband has adhesive applied to both surfaces, is cured and cooled in the same manner as the previous one and laid on the core assembly.

(5) The second veneer face is applied to the built-up construction.

(6) The laid-up assembly is pressed and cured via the hot plate process.

(7) After pressing, the 1 1/2 hour fire door is then trimmed to tolerances, sanded, patched and inspected for imperfections.

With respect to the foregoing, the Weldrok core comprises a material which is rated as incombustible by the Underwriters Laboratory. It is very dimensionally stable and has a minimum compressive strength of about 550 lbs./sq. in. The material is an excellent heat insulator and is easily machined. The material is insoluble in water and was tested in accordance with standard test methods for fire hazard classification of building materials.

The inorganic materials such as Marinite (36 pound) is manufactured by Johns-Manville and is an insulating material composed of asbestos fibers, diatomaceous silica and an inorganic binder. It is fireproof and has a low thermal expansion coefficient. This material was tested by the Underwriters Laboratories and has a flame spread rating of 0. This material is used for the inner stiles and rails. This type of structural frame adds appreciably in preventing burnout around the core materials.

The outer stiles and rails are composed of a fire retardant treated lumber. This is secured by means of an aqueous salt solution. The soft maple is treated to refusal via the vacuum pressure full cell process with a method similar to the Protexol Class "A" treatment. This material was tested in accordance with ASTM E160-50 for combustibility properties of treated wood.

The adhesive used to bond the Weldrok core, inner and outer stiles and rails can either be urea-formaldehyde reinforced with a precatalyzed phenolic resin (HP-401D) or a phenol resorcinol adhesive resin. This is applied to one surface of the Marinite which is then placed against the Weldrok core. The adhesive is also applied to one surface of the treated lumber and placed against the Marinite. This entire assembly is then cured via a dielectric method.

The sizing formulation is as follows:

	Pts. by wt.
BRLA-1030 (Bakelite Co. Union Carbide & Co.)	30
(BRLA-1030 is a slightly alkaline phenol formaldehyde resin of very low molecular weight to insure penetration in depth.)	
HP-401D—Borden Chem. Co. ¹	30
Methanol	60
Triton X-100 (Rohm & Haas)	0.2
(Triton X-100 (a nonionic wetting agent) is isooctyl phenyl polyethoxy ethanol.)	
¹ A dry precatalyzed phenolic powdered resin glue.	

The purpose of this sizing is to penetrate and seal the inorganic material such that when a compatible phenol-heat resistant resin is used for bonding, it will give better holding qualities and strength. The sizing formulation is comprised of different phenol ingredients plus an additive to aid in penetration. This sizing is of a very light viscosity.

After the sizing material is applied, it is then semi-precured in the infra-red oven at approximately 160° F. for 35 seconds.

The asbestos elastomer crossband, which is approximately .038" to .042" thick is also phenolic sized and semi-precured. This asbestos crossband material contributes much to the product for the coefficients of linear expansion and contraction of the various organic materials to render a better product. Not only does this help withstand the rigor of the U.L. tests and the ASTM Specifications for the fire and hose stream tests and application, but further aids in dimensional stability of the product.

The phenolic adhesive used for fabrication is a phenolic type similar to that produced by the Borden Chemical Company. The actual formulation is as follows:

Materials:	Percentage
HP-401D	45.0
Water	33.7
Walnut or pecan shell	11.2
Methanol	10.1

The above mentioned phenol adhesive mixture is applied to both surfaces of the asbestos crossband at a rate of approximately 35 pounds per thousand square feet of single glue line. It is then immediately flashed off by means of a circulating air; and semi-precured under an infra-red oven at approximately 160° F. for 45 seconds.

The material is then immediately cooled with cooling units and placed on the veneer faces. The entire laid-up assembly is then pressed and cured at 180 pounds per square inch at 300° F. for 10 minutes via the hot plate process.

What is claimed is:

1. A fire door comprising a core composed essentially of calcium silicate subhydrate, a peripheral frame surrounding said calcium silicate subhydrate on all sides to form a continuous outside area, said peripheral frame composed essentially of asbestos fibers, diatomaceous earth and an inorganic binder, and a crossband on each side of said core composed essentially of an asbestos neoprene composition, and said crossbands extending over the entire core and frame in a single plane direction.

2. A fire door as set forth in claim 1 wherein an untreated, flammable veneer is adhered to at least one of said crossbands.

3. A fire door as set forth in claim 1 wherein an outer frame surrounds said peripheral frame of asbestos fibers, diatomaceous earth and inorganic binder.

4. A fire door as set forth in claim 3 wherein a flammable decorative veneer is adhered to at least one of said crossbands.

5. A fire door as set forth in claim 3 able to withstand a 1 1/2 hour Underwriters Laboratories Fire Test, wherein said outer frame is treated fire retardant wood, and a

flammable face is adhered to at least one of said cross-bands which face comprises at least one ply of fibrous material.

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