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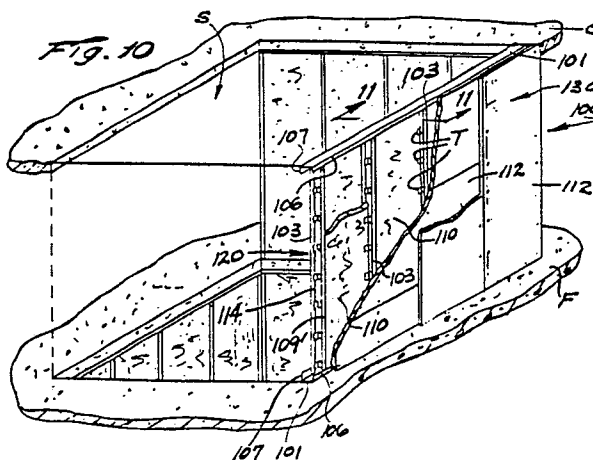
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(54) Use of fibrous mat-faced gypsum board in shaft wall assemblies and improved fire-resistant board.

(57) Shaft wall assemblies (100) comprise fire-resistant framework (101, 103) and gypsum board (110) which is faced with fibrous mat supported by the framework. The gypsum board (110) has a core containing mineral fibres in an amount sufficient to improve the fire-resistant properties of the board.



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USE OF FIBROUS MAT-FACED GYPSUM BOARD IN SHAFT WALL ASSEMBLIES AND IMPROVED FIRE-RESISTANT BOARD

FIELD OF THE INVENTION

This invention relates to an improved structural component for use in fire-resistant applications, for example, in hollow shaft wall assemblies of the type used in constructing elevator shafts and stairwells in buildings. More particularly, this invention relates to fibrous mat-faced gypsum board having improved fire-resistant properties and to its use in various structural applications.

This invention will be described initially in connection with its use in a shaft wall assembly, but, as will be explained hereinafter, its use has wider applicability.

A shaft wall assembly is used typically to line shafts which commonly extend through a plurality of floors in a building. Examples of such shafts are elevator shafts, air shafts, and stairwells. A popularly used shaft wall assembly is constructed from panels of paper-faced gypsum board which are supported in place by metal framework. The design of the assembly is such that the gypsum board panels, including the panels which line and face the shaft, can be installed from one side, that is, away from the shaft being enclosed. Such assemblies are constructed in place by workmen who are supported by the floor through which the shaft extends. This eliminates the necessity for construction of internal scaffolding or other supports for workmen within the shaft.

It is mandatory that shaft wall assemblies possess certain characteristics for commercial acceptability. For example, it is particularly important that gypsum board used in the shaft wall assemblies possess fire-resistant qualities that enable the assemblies utilizing them to meet the strict fire regulations of most municipality codes. Still further, it should be kept in mind that in an elevator, the gypsum board panels used in lining an elevator shaft must be able to withstand significant forces that are imposed on them by compressed air which is generated by ascending and descending elevator cars. Such forces can involve air pressure loads as high as 15 pounds per square foot. Acoustical insulating characteristics are also desirable in shaft walls.

The present invention relates to improved shaft wall assemblies and also improved fire-resistant fibrous mat-faced gypsum board which can be used in such assemblies, as well as other types of structural applications.

Currently used shaft wall assemblies include also in their structure gypsum board comprising a core of set gypsum sandwiched between paper cover sheets. A shaft wall assembly that is used widely at the present time consists of a metal framework which supports a plurality of plies of panels of gypsum board. Such assemblies are described in detail hereinbelow. In brief, one wall of the assembly, which itself surrounds the open shaft, comprises a pair of horizontally disposed metal J-tracks (one of the pair of tracks being fastened to the ceiling and the other of the pair being fastened to the floor) and a plurality of spaced vertically disposed metal "I-studs" which are frictionally held within the J-tracks. Panels of gypsum board which line the shaft being enclosed are supported by the J-tracks and the I-studs. One or more facing layers of gypsum board panels are fastened to the J-tracks and I-studs on the side of the metal assembly opposite the shaft being enclosed. By increasing the number of facing layers and/or the thickness of the gypsum boards, the fire resistance of the assembly can be improved.

The core of gypsum board used in such commercial shaft wall assemblies usually contain chopped glass fibers as an additive to improve the fire-resistant properties of the board. However, to achieve the necessary fire rating for the assembly, such boards have a relatively high density. This adds to shipping costs and makes installation more difficult. In addition, the amount of chopped glass fibers added to the core is not insignificant and adds to the boards' cost. In addition, the paper facing sheets smoke when exposed to the heat of fire and eventually burn.

Gypsum boards suggested for use in shaft wall assemblies, in which the flammable paper facing sheets have been eliminated in favor of glass fiber mat or chopped glass fibers embedded in and covered by set gypsum of the surface layers of the gypsum board are described in U.S. Patent Nos. 4,195,110 and 4,265,979. It is believed that the boards described in these patents have never been commercially used for a variety of reasons.

The '110 patent discloses a gypsum board formed from the set product of a gypsum slurry sandwiched between two surface layers of glass fiber-containing set gypsum composition. The glass fibers may be in the form of rovings, continuous strand mat or chopped glass. The single example of gypsum board which is the subject of the patent shows a board of relatively high density, namely about 52 lbs/cu. ft. This is about 1 to 2 pounds higher than the conventional paper-faced board.

which are referred to in the '110 patent. The patent discloses also that the board which is the subject of the patent has improved flexural strength and does not smoke when exposed to the heat of fire.

The '979 patent discloses a gypsum board that has chopped glass fibers concentrated in the surface portions of the core of the board. In the manufacture of these boards, a mixture of chopped glass fibers and gypsum is hydrated and formed into sheets. Before the sheets set, a "conventional" gypsum slurry is sandwiched between the unset sheets, and the resulting three layered composite is compressed and allowed to dry. The patent also discloses that such boards, in addition to being "highly fire resistant and smoke resistant" and "relatively light", have improved flexural strength over conventional paper faced boards. It is apparent from the disclosure that the patentees contemplate a relatively dense gypsum board, the density of the surface sheet being reported as 81 lbs/cu.ft.

Manufacture of each of the gypsum boards which are the subjects of the aforementioned patents necessitates special handling of the glass-containing surface layers between which the core is sandwiched, foreclosing manufacture of the boards on a conventional gypsum board-making apparatus.

Our European Patent Application No. 84309124.0 (EP-A-0,154,094), which forms part of the state of the art solely by virtue of Article 54(3) EPC, discloses gypsum board comprising a set gypsum core faced with a fibrous mat and mentions its use in shaft wall assemblies generally comprising metal framework and panels of the gypsum board.

In accordance with the present invention, there are provided an improved shaft wall assembly including a gypsum-based structural component and also gypsum board having improved fire-resistant properties.

SUMMARY OF THE INVENTION

In accordance with the invention described and claimed in the present application, there is provided a shaft wall assembly comprising fire-resistant framework and, supported by said framework, fibrous mat-faced gypsum board. In preferred form, the assembly comprises glass mat-faced gypsum board supported by metal framework. As is described in detail hereinbelow, said glass mat-faced gypsum board comprises a set gypsum core which includes one or more fire-resistant additives, most preferably glass fibers.

Another aspect of the invention described and claimed herein encompasses fibrous mat-faced gypsum board having a core which includes one or more additives which are effective in improving the fire-resistant characteristics of the board. In preferred form, the invention includes glass mat-faced gypsum board having a core which includes glass fibers in a fire-resistant improving amount, for example, about 0.07 to about 0.2 wt.%, based on the dry mixture from which the core is made.

A further aspect of the present invention includes the provision of a glass mat-faced gypsum board which has significantly improved fire-resistant properties notwithstanding the presence in the board core of a relatively small amount of fire-resistant additives such as glass fibers and the use of a core which has a relatively low density.

As will be described hereinbelow, the improved fire-resistant board of the present invention can be used to excellent advantage in shaft wall assemblies, as mentioned above, and, in addition, the board can be used to excellent advantage in the numerous and varied applications in which conventional paper-faced gypsum board is used. Such applications include, for example, the use of the board as structural components of walls, ceilings, partitions, and the like.

The advantages which flow from the provision of the improved fire-resistant board of the present invention are numerous and important. For example, the invention affords the manufacture of a gypsum-based product which has fire-resistant properties not heretofore available in gypsum board of popularly used thicknesses and having a relatively low weight. Furthermore, such advantages can be achieved by manufacturing the board of the present invention by the use of existing gypsum-manufacturing equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a somewhat diagrammatic, fragmentary side elevational view illustrating portions of a manufacturing line for producing gypsum board of a type suitable for use in the manufacture of gypsum board prepared for use in accordance with the present invention;

Figure 2 is an enlarged fragmentary sectional view, taken as indicated toward the left of Figure 1, of an underlying fiber glass mat used in the manufacture of the gypsum board;

Figure 3 is a fragmentary plan view taken as indicated by the line 3-3 on Figure 2;

Figure 4 is an enlarged sectional view taken as indicated toward the right on Figure 1 and illustrating both underlying and overlying fiber glass mats, with intervening gypsum composition, used in the manufacture of the board;

Figure 5 is a fragmentary plan view taken as indicated by line 5-5 on Figure 4;

Figure 6 is a fragmentary bottom view taken as indicated by the line 6-6 on Figure 4 and illustrating the bottom surface of the underlying mat of the board;

Figure 7 is a transverse sectional view of an edge portion of the completed board, this view being taken as indicated by the line 7-7 on Figure 4;

Figure 8 is a further enlarged fragmentary sectional view taken as indicated toward the top of Figure 4;

Figure 9 is a further enlarged fragmentary sectional view taken as indicated toward the bottom of Figure 4;

Figure 10 is an elevated view illustrating installation of a typical shaft wall assembly enclosing a shaft between floors of a building;

Figure 11 is a diagrammatic vertical sectional view taken along line 11-11 through the shaft wall assembly illustrated in Figure 10; and

Figure 12 is a diagrammatic horizontal sectional view taken along line 12-12 through the shaft wall assembly illustrated in Figure 11.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to a description of the improved gypsum board that can be used in improved shaft wall assemblies of the present invention, it comprises a set gypsum core faced with a fibrous mat. The gypsum core is basically of the type used in those gypsum structural products which are known as gypsum wallboard, dry wall, gypsum board and gypsum sheathing. The core of such a product is formed by mixing water with powdered anhydrous calcium sulfate or calcium sulfate hemihydrate - ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$), also known as calcined gypsum; and thereafter allowing the mixture to hydrate or set into calcium sulfate dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), a relatively hard material. The core of the product will in general comprise at least about 85 wt.% of set gypsum.

The composition from which the set gypsum core is made can include optional constituents, including, for example, those included conventionally in gypsum sheathing. Examples of such constituents include set accelerators, retarders, forming agents, and dispersing agents.

The set gypsum core is faced with a fibrous mat. The fibrous mat should be sufficiently porous to permit water in the aqueous gypsum slurry from which the gypsum core is made to evaporate therethrough. As described in detail below, the fibrous mat-faced gypsum board can be made efficiently by forming an aqueous gypsum slurry which contains excess water and placing thereon the fibrous mat. Aided by heating, excess water evaporates through the porous mat after the calcined gypsum sets.

The fibrous mat comprises material which is capable of forming a strong bond with the set gypsum comprising the core of the gypsum board. Examples of such materials include a mineral-type material such as glass fibers and synthetic resin fibers. The mat can comprise continuous or discrete strands or fibers and be woven or nonwoven in form. Nonwoven mats such as chopped strand mat and continuous strand mat can be used satisfactorily and are less costly than woven materials. The strands of such mats are bonded together by suitable adhesive. The mat can range in thickness, for example, from about 15 to about 40 mils, with a thickness of about 25 to about 35 mils being preferred. The aforementioned fibrous mats are known and are commercially available in many forms.

The preferred fibrous mat is a fiber glass mat comprising fiber glass filaments oriented in random pattern and bound together with a resin binder. Fiber glass mats of this type are commercially available, for example, those sold under the trademark DURA-GLASS by Manville Building Materials Corporation and those sold by Elk Corporation as BUR or shingle mat.

Although improvements can be realized by the use of a gypsum core which has but one of its surfaces faced with fibrous mat as described herein, it is preferred that both surfaces of the core be faced with substantially the same fibrous material. If the surfaces of the core are faced with materials that have different coefficients of expansion, the core tends to warp. Fibrous mat-faced gypsum board and methods for making the same are known, for example, as described in Canadian Patent No. 993,779 and U.S. Patent No. 3,993,822.

In accordance with the present invention, gypsum board comprising a set gypsum core faced with a fibrous mat, as described hereinabove, and preferably gypsum board comprising a set gypsum core sandwiched between two sheets of porous glass mat, is used as a component of a shaft wall assembly or similar assembly in the interior of a building. In such application, the fibrous mat-faced board can be used to particular advantage in place of conventional paper-faced gypsum core board or shaft liner panels, the core of which generally includes fire-resistant additives. Shaft wall assembly

blies including the fibrous mat-faced board have improved fire endurance relative to assemblies which include paper-faced gypsum core board. As mentioned hereinabove, assemblies of this type generally comprise metal framework or studs for support of the gypsum panels which form the walls of the shafts of elevators, stairwells, air shafts and the like. Examples of such assemblies are shown in U.S. Patent Nos. 4,047,355; 4,324,082; and 4,364,212. Fibrous mat-faced board, as described herein, can be used, for example, in the assemblies described in the aforementioned patents and the shaft liner panels and/or as facing panels.

In these types of applications where fire-resistant properties are considered important, the core of the fibrous mat-faced gypsum board includes one or more additives which improve the ability of the set gypsum composition to maintain its integrity when subjected to the heat of fire. Examples of materials which have been reported as being effective for improving the fire-resistant properties of gypsum products include mineral fibers such as, for example, glass fibers, asbestos fibers, and calcium sulfate whisker fibers. A mixture of one or more of such fibers can be used. Other exemplary materials which are known for use in conventional fire-resistant gypsum board are unexpanded vermiculite, clay, colloidal silica and colloidal alumina. Typically, mineral fibers, and particularly glass fibers, are used in admixture with one or more of the aforementioned exemplary materials. For example, see U.S. Patent No. 3,616,173, assigned to the same assignees as the present invention.

A preferred material for use in improving the fire-resistant properties of the fibrous mat-faced gypsum board comprises chopped glass fibers, for example, as described in aforementioned U.S. Patent No. 3,616,173, the disclosure of which, as it relates to glass fibers, is incorporated herein by reference. Briefly described, said glass fibers are of the drawn textile glass fiber type, produced as continuous individual filaments and having a diameter of from about 0.0002 to about 0.001". The individual filaments are usually grouped into strands, the filaments having coated thereon a relatively weak, bonding type material, such as, for example, starch or other water softenable or soluble coating material. The bonding material helps to prevent abraiding between the several grouped filaments of each strand. Prior to the addition of the loosely bonded textile glass fibers to the core composition, the strands are cut into short lengths such as, for example, 1/8" to 1". Once added to the aqueous slurry composition from which the core is made, the bonding or coating material dissolves, and the strands separate into individual fibers which become uniformly distributed throughout the slurry as the slurry is mixed.

The presence of mineral fibers in the core of fibrous mat-faced gypsum board in accordance with the present invention results in a product which has unusually high fire-resistant characteristics. For example, the presence of a predetermined amount of chopped glass fibers in the core of glass mat-faced gypsum board of predetermined thickness provides a product which has fire-resistant characteristics that are significantly better than those of conventional paper-faced gypsum board that has a like amount of glass fibers in its core and a like thickness. The effects which flow from this development are significantly important and can desirably be taken advantage of in several different ways. For example, the development can be used to produce a glass mat-faced gypsum board which has a lower density than that of conventional paper-faced, glass fiber-containing gypsum board without sacrificing fire-resistant properties. Similarly, significantly lower amounts of glass fibers can be used in the glass mat-faced board without sacrificing fire-resistant properties.

The amount of glass fibers in the core should be at least about 0.03 wt.% and can vary over a wide range, for example, from about 0.03 to about 0.3wt.% based on the total weight of the dry ingredients comprising the core, that is, the total weight of the ingredients before they are combined with water to make the aqueous slurry from which the core is formed. In preferred form, the amount of glass fibers comprises about 0.07 to about 0.2 wt.%.

The core of the fibrous mat-faced board for use in fire-resistant applications can be fabricated according to available techniques into a density of desired value. For a relatively thick board, for example, a thickness in excess of one inch, the density of the core can be as low as about 35 lb/cu.ft. In conventional paper-faced board having a relatively low density, the bond between the gypsum core and paper facings is generally unsatisfactory due to the low density of the core. Preferably, the density of the core should not exceed about 47 lbs/cu.ft. It is believed that a density within the range of about 40 to about 47 lbs/cu. ft. will be used most widely. Board having a core density of about 41 to about 45 lbs/cu. ft. has a particularly good combination of properties, including good fire-resistant characteristics and relatively low weight.

Another aspect of the present invention comprises a glass mat-faced gypsum board having a core comprising the set product of calcium sulfate and at least about 0.03 wt.% of glass fibers, said core having a density ranging from about 41 to about 47 lbs./cu.ft., and the amounts and proportions of ingredients comprising the core being such that when said board has a thickness of about 1

inch, a shaft wall test section including said one-inch board has a fire endurance rating of at least about three hours. The method for evaluating said fire endurance rating is described in detail hereinbelow in the Example section.

It should also be understood that included within the scope of this invention is glass mat-faced gypsum board which has a thickness less than or greater than one inch, so long as the core density falls within the above range, so long as the core includes the ingredients as set forth above, and so long as the particular core formulation involved, when part of a one-inch board having said density yields a board which results in said rating. It will be appreciated that a board having a thickness less than one inch generally will not have as good fire-resistant properties as a one-inch board even if the densities of the cores and the ingredients, and the amounts thereof, from which the cores are formed are the same. On the other hand, a board having a thickness greater than one inch will generally have better fire-resistant properties than a one-inch core, even though the core densities and the ingredients, and amounts thereof, from which the cores are formed are the same.

For use as shaft liner panels in a shaft wall assembly, it is recommended that there be used glass mat-faced gypsum board having a thickness of about 1", and core density of about 41 to about 47 lbs./cu.ft., preferably no greater than about 45 lbs./cu. ft., and prepared from a formulation containing about 0.03 to about 0.3 wt.% of glass fibers. In such an assembly, it is believed that the glass mat surface of the gypsum board assists in conducting heat away from the framework which supports the board, thus leading to improvements in the fire endurance of the assembly.

Glass mat-faced gypsum board, as described herein, and including also such board having a glass fiber-containing core, can be used also as board panels in one or more of the plies of facing layers which comprise shaft wall assemblies. In addition, the board can be used to advantage in any application of the type in which conventional fire-resistant gypsum board is generally used. The board can be fabricated into thicknesses which are popularly used, for example 1/2", 5/8", 3/4" and 1".

There are advantages to using that form of the board in which at least one of the surfaces of the board has set gypsum over substantial area portions thereof. The set gypsum appears to aid in dissipating heat as it is consumed in driving off the water hydration of set gypsum.

In applications where both fire resistance and improved weathering characteristics are desired, both fire-resistant and water-resistant additives can be included in the core.

The use of certain water-resistant additives may reduce the fire resistance of the board. In the event this occurs, such reduction in fire resistance can be offset by making the core more dense. In this type of situation, it is recommended that the core density be about 48 to about 55 lbs/cu.ft. to provide a 5/8" board that achieves a one-hour fire rating according to ASTM E-119.

The preferred means for imparting water-resistant properties to the gypsum core is to include in the gypsum composition from which the core is made one or more additives which improve the ability of the set gypsum composition to resist being degraded by water, for example, to resist dissolution. In preferred form, the water resistance of the core is such that it absorbs less than about 10%, preferably less than about 7.5% and most preferably less than about 5% water when tested in accordance with ASTM method C-473 with only the edges exposed.

The fibrous mat for use in structural systems described herein has substantially better water-resistant properties than the conventional paper facing of gypsum wallboard or sheathing. Nevertheless, evaluations have shown that the bond between the fibrous mat and gypsum core can deteriorate relatively quickly under the influence of water. For example, samples exposed to the weather showed loosening at the glass fiber facing within one to two months. In contrast, evaluations of water-resistant gypsum core faced with fibrous mat, as described herein, have shown the bond between the mat and core resists being degraded by water for indefinite periods of time.

Examples of materials which have been reported as being effective for improving the water-resistant properties of gypsum products are the following: poly(vinyl alcohol), with or without a minor amount of poly(vinyl acetate); metallic resins; wax or asphalt or mixtures thereof; a mixture of wax/or asphalt and also cornflower and potassium permanganate; water insoluble thermoplastic organic materials such as petroleum and natural asphalt, coal tar, and thermoplastic synthetic resins such as poly(vinyl acetate), poly(vinyl chloride) and a copolymer of vinyl acetate and vinyl chloride and acrylic resins; a mixture of rosin soap, a water soluble alkaline earth metal salt, and residual fuel oil; a mixture of petroleum wax in the form of an emulsion and either residual fuel oil, pine tar or coal tar; a mixture comprising residual fuel oil and rosin; aromatic isocyanates and diisocyanates; organohydrogenpolysiloxanes; a wax-asphalt emulsion with or without such materials as potassium sulfate, alkali and alkaline earth aluminates, and Portland cement; a wax-asphalt emulsion prepared by adding to a blend of molten wax and asphalt an oil-soluble, water-dispersing

emulsifying agent, and admixing the aforementioned with a solution of casein which contains, as a dispersing agent, an alkali sulfonate of a polyaryl-methylene condensation product.

A preferred material for use in improving the water-resistant properties of the gypsum core comprises wax-asphalt emulsion, species of which are available commercially. The wax portion of the emulsion is preferably a paraffin or microcrystalline wax, but other waxes can be used also. The asphalt in general should have a softening point of about 115°F, as determined by the ring and ball method. The total amount of wax and asphalt in the aqueous emulsion will generally comprise about 50 to 60 wt.% of the aqueous emulsion, with the weight ratio of asphalt to wax varying from about 1 to 1 to about 10 to 1. Various methods are known for preparing the wax-asphalt emulsion, as reported in U.S. Patent No. 3,935,021 to D.R. Greve and E.D. O'Neill, assigned to the same assignee as the present invention. Commercially available wax asphalt emulsions that can be used in the composition described herein are sold by United States Gypsum Co. (Wax Emulsion), Monsey Products - (No. 52 Emulsion) and Douglas Oil Co. (Docal No. 1034). The amount of wax-asphalt emulsion used can be within the range of about 3 to about 10 wt.%, preferably about 5 to about 7 wt.%, based on the total weight of the ingredients of the composition from which the set gypsum core is made, said ingredients including the water of the wax-asphalt emulsion, but not including additional amounts of water that are added to the gypsum composition for forming an aqueous slurry thereof.

A particularly preferred material for use in improving the water-resistant properties of the gypsum core comprises a mixture of materials, namely, poly(vinyl alcohol) and wax-asphalt emulsion of the aforementioned type. The use of such additives to improve the water resistance of gypsum products is described in aforementioned U.S. Patent No. 3,935,021.

The source of the poly(vinyl alcohol) is preferably a substantially completely hydrolyzed form of poly(vinyl acetate), that is, about 97 to 100% hydrolyzed poly(vinyl acetate). The poly(vinyl alcohol) should be cold-water insoluble and soluble in water at elevated temperatures, for example, at temperatures of about 140 to about 205°F. In general, a 4 wt.% water solution of poly(vinyl alcohol) at 20°C will have a viscosity of about 25 to 70 cp as determined by means of the Hoesppler falling ball method. Commercially available poly(vinyl alcohols) for use in the composition of the present invention are available from E. I. du Pont de Nemours and Company, sold under the trademark "Elvanol" and from Monsanto Co., sold under the

trademark "Gelvatol". Examples of such products are Elvanol, Grades 71-30, 72-60, and 70-05, and Gelvatol, Grades 1-90, 3-91, 1-60, and 3-60. Air Products Corp. also sells the product as WS-42.

The amounts of poly(vinyl alcohol) and wax-asphalt emulsion used should be at least about 0.05 wt.% and about 2 wt.% respectively. The preferred amounts of poly(vinyl alcohol) and wax-asphalt emulsion are about 0.15 to about 0.4 wt.% and about 3.0 to about 5.0 wt.% respectively.

Unless stated otherwise, the term "wt. %" when used herein and in the claims means weight percent based on the total weight of the ingredients of the composition from which the set gypsum core is made, said ingredients including the water of the wax-asphalt emulsion or the water associated with other additives, but not including additional amounts of water that are added to the gypsum composition for forming an aqueous slurry thereof.

The fibrous mat of the gypsum board described herein is also a significant factor in reducing transmission of sound, a desirable characteristic, which can be taken advantage of in elevator shaft wall assemblies, as well as other structural assemblies where reduced sound transmission is desired. For example, in partition assemblies wherein a fibrous mat-faced board provides a support surface for a facing layer of material adhesively fastened thereto, the adhesive interface between the board and facing layer provides a resilient connection which tends to dissipate sound energy, thereby providing a sound resistant assembly.

An attractive feature of the present invention is that the fibrous mat-faced gypsum board can be made utilizing existing wallboard manufacturing lines, for example, as shown somewhat diagrammatically in Figure 1. In conventional fashion, dry ingredients (not shown) from which the gypsum core is formed are pre-mixed and then fed to a mixer of the type commonly referred to as a pin mixer 2. Water and other liquid constituents (not shown) used in making the core are metered into the pin mixer 2 where they are combined with the dry ingredients to form an aqueous gypsum slurry. Foam is generally added to the slurry in the pin mixer to control the density of the resulting core. The slurry 4 is dispersed through one or more outlets at the bottom of the mixer 2 onto a moving sheet of fibrous mat 6. The sheet of fibrous mat 6 is indefinite in length and is fed from a roll (not shown) of the mat.

As is common practice in the manufacture of conventional paper-faced gypsum board, the two opposite edge portions of the fibrous mat 6 are progressively flexed upwardly from the mean plane of the mat 6 and then turned inwardly at the margins so as to provide coverings for the edges

of the resulting board 40. In Figure 1, this progressive flexing and shaping of the edges of the mat 6 are shown for only one side edge of the mat and the conventional guiding devices which are ordinarily employed for this purpose are omitted from the figure for the sake of clarity. Figure 7 shows also score marks 10 and 10A of the mat 6, the score marks permitting the formation of good edges and flat surfaces. The score marks 10 and 10A are made by a conventional scoring wheel 12. An advantage of using the preferred form of glass fiber mat is that it is capable of being scored and edged like conventional paper facing:

Another sheet of fibrous mat 16 is fed from a roll (not shown) onto the top of slurry 4, thereby sandwiching the slurry between the two moving fibrous mats which form the slurry. The mats 6 and 16 with the slurry 4 sandwiched therebetween enter the nip between the upper and lower forming or shaping rolls 18 and 20, and are thereafter received on a conveyor belt 22. Conventional edge guiding devices, such as indicated at 24 shape and maintain the edges of the composite until the gypsum has set sufficiently to retain its shape. In due course, sequential lengths of the board are cut and further processed by exposure to heat which accelerates the drying of the board by increasing the rate of evaporation of excess water in the gypsum slurry.

With reference to Figure 7, it has been observed that the set gypsum of the core 42 is effective in forming satisfactory bonds with the mats and between the edge portions of the overlying mat 16 and the overlapped edge portion 6A of the underlying mat 6, thus making it unnecessary to use a bond improver in the slurry or an edge paste to form the aforementioned bonds.

The preferred form of mats 6 and 16, as shown in Figures 2 and 3, comprise glass fiber filaments 30 oriented in random pattern and bound together with a resin binder (not shown).

A preferred form of glass fiber mat-faced gypsum board 40 is shown in Figures 4 and 7. It comprises one in which the set gypsum of the core 42 penetrates substantially through the thickness of the mat 6 over substantial area portions thereof and in which the set gypsum of the core 42 penetrates the mat 16 partially, with the surface being thus substantially free of set gypsum. The gypsum-free surface of mat 16, as seen in Figure 8, is highly textured, and provides an excellent substrate for adhering thereto an overlying component inasmuch as it comprises many interstices into which an adhesive composition can flow and bond.

The phrase "substantially penetrated by set gypsum", as used herein, means that the set gypsum of the core, extends from the mat surface which is contiguous to the core to the outer mat

surface and coats glass fibers on the outer surface with a thin film of set gypsum to the extent that the outline of glass fibers can be seen through the thin film of set gypsum. The phrase "over substantial area portions of the outer surface", as used herein, means that about 30 to 75% of the outer surface area of the mat is substantially penetrated by set gypsum. Preferably, about 45 to about 55% of the outer surface area of the mat is substantially penetrated by set gypsum. Accordingly, the gypsum-coated surface of this preferred embodiment of the board comprises a surface that has a roughened or patterned appearance; it does not comprise a smooth continuous coating of set gypsum. This preferred form of board can be formed with relatively small amounts of gypsum slurry being deposited on the underlying support surface, thus minimizing the need to clean the surface of the board-forming equipment.

The need for such cleaning can be substantially avoided by adjusting the viscosity of the slurry so that it penetrates but part-way through the underlying fibrous mat, for example, up to about 50% of its thickness. Thus, this preferred form of board has two gypsum-free fiber-faced surfaces.

The manufacture of the aforementioned preferred forms of board can be accomplished by controlling the viscosity of the aqueous slurry of the calcined gypsum in a manner such that the slurry penetrates the underlying and overlying mats to the desired degree. In manufacturing each of the aforementioned preferred forms of board, the viscosity of the slurry should be such that it penetrates about 10 to 50% of the thickness of the overlying mat over the entire surface area thereof.

The recommended means for controlling the viscosity of the slurry is to add thereto a viscosity-control agent. Such viscosity-control agents are known in the field of gypsum board manufacture. A preferred viscosity-control agent is paper fiber. Examples of other agents that can be used are cellulosic thickeners, bentonite clays, starches, and gypsum whisker fibers.

The particular viscosity values that are used in the manufacturing operation can vary from one application to the next, depending on the porosity of the mat, the hydration rate of the calcined gypsum and the desired penetration of the slurry. Accordingly, for any particular application, the viscosity value is best determined empirically.

In using the preferred form of glass fiber mat, as described above, to manufacture the aforementioned preferred forms of board, developmental work has shown that satisfactory results can be achieved utilizing a gypsum slurry having a viscosity within the range of about 5000 to 7000 cp. As used herein, the viscosity value refers to Brookfield viscosity measured at a temperature of 70°F at 1C

rpm utilizing paddle No. 3. It should be appreciated that the amount of viscosity-control agent added to the slurry to give the desired viscosity will vary depending on the particular agent used and the specific viscosity desired.

The manufacture of cores of predetermined densities can be effected by using known techniques, for example, by introducing an appropriate amount of foam into the aqueous gypsum slurry from which the core is formed. There are weight advantages that can be realized by the use of fibrous mat-faced gypsum board in fire-resistant applications in that fibrous mats which are lighter in weight than conventional paper facing are available. For example, the weight of a widely used paper facing in the manufacture of conventional gypsum sheathing is in the range of about 120 lbs/1000 sq.ft. of board, whereas the weight of a preferred form of glass fiber mat for use in the present invention is about 40 lbs/1000 sq.ft. of board.

With reference to Figures 10, 11 and 12, there is shown an example of a typical commercial shaft wall assembly in which fibrous mat-faced gypsum board as described herein can be used. Shaft wall assembly 100 comprises metal framework consisting of ceiling and floor-mounted J-tracks 101 and I-studs 103 for supporting gypsum board panels 110 and 112. J-tracks 101 are fastened by bolts 104 to the ceiling C and to the floor F adjacent to the shaft S to be enclosed. Each J-track has a short leg 106 and a long leg 107, the long leg 107 lying in substantially the same plane as the shaft side 120 of shaft wall assembly 100. I-studs 103 are positioned vertically between the ceiling and floor J-tracks 101. The terminal ends of I-studs 103 are friction-fit between the legs 106 and 107 of the ceiling and floor J-tracks. Generally described, I-studs 103 comprise flanges 109 and 109' extending perpendicularly from an intermediate body portion 114.

Tabs T are cut and folded out of the metal sheet from which I-studs 103 are made. The forming of such tabs results in forming holes 140 in body portion 114 of the I-studs.

Gypsum board panels 110 comprising the shaft liner panels of the assembly, are positioned between legs 106 and 107 of J-tracks 101, with the vertical edges of said panels being friction-fit between the I-stud tabs T and flanges 109. Facing layers of gypsum board panels 112 are fastened by screw fasteners 113 to the face side 130 of shaft wall assembly 130. Two facing layers or plies of gypsum board panels 112 are illustrated, although it should be understood that additional face layers of gypsum board may be applied, as de-

sired. Facing layers of gypsum board may also be applied to the shaft side of the assembly in stairwell applications where a finished wall surface is desired.

In the embodiment shown in Figures 10 to 12, gypsum board panels 110 (shaft liner panels of the assembly) are intended to be shown as comprising a gypsum core sandwiched between and faced with glass mats, as described herein, and gypsum board panels 112 (the facing layers of the assembly) are intended to be shown as comprising a gypsum core sandwiched between and faced with paper. Exemplary alternative embodiments include the use of panels comprising a gypsum core having but one side faced with a fibrous mat and oriented in the assembly with the "mat" facing the shaft and the use of fibrous mat-faced gypsum board in one or more plies of the facing layers.

EXAMPLES

In the examples which follow, glass fiber mat-faced gypsum boards falling within the scope of the present invention were installed and evaluated for fire endurance in test sections of conventional shaft wall assemblies of the general type shown in the drawings.

The metal components of the shaft wall metal framework were supplied by Georgia Pacific Corporation and were manufactured from 25 gauge hot dipped galvanized steel. The components consisted of four J-tracks having a 2 1/2" wide base portion from which 2 1/4" and 1" legs extended and a single I-stud which was 1 1/2" wide and 2 1/2" deep. The J-tracks were fastened by bolts to horizontal and vertical edges of a masonry framing structure. The ends of the I-stud were friction-fit between the legs of the upper and lower horizontally positioned J-tracks. For convenience, the side of the assembly defined by the mean plane of the long legs of the J-tracks is referred to hereafter as the "shaft side"; the side of the assembly defined by mean plane of the short legs of the J-tracks is hereafter referred to as the "face side."

In each of the shaft wall assemblies that were tested, there were used two 1" thick gypsum boards having respective dimensions of 15" x 66" and 24" x 66". The boards were inserted between the legs of the upper and lower horizontal J-tracks on either side of the I-stud, and their longest dimensions vertically oriented. Vertical edges of the boards, positioned adjacent the I-stud, were friction-fit between the I-stud tabs and flanges, thereby sandwiching the I-stud between the edges of the boards. The opposite vertical edges of the

boards were secured to the long legs of the vertically positioned J-tracks by 1 1/4" Type S screws 24" on center (O.C.) such that the long legs overlapped the boards on their shaft side.

Each of the glass fiber mat-faced gypsum boards that were tested had a substantially gypsum-free face and a face having gypsum over substantial area portions thereof. Each of the boards was installed in its test assembly so that its gypsum-free face was exposed to the shaft side of the assembly. Following installation of the glass fiber mat-faced gypsum boards in the metal as-

<u>Time (minutes)</u>	<u>Temp. (°F)</u>
5	1000
10	1300
30	1550
60	1700

Temperature measurements of the test assembly were made by eight Chromel-Alumel (Type K) thermocouples, four of which were positioned on the furnace exposed side and the remaining four of which were positioned on the unexposed side of the assembly.

Fire endurance of each assembly tested was measured as time taken for either (1) the average temperature of the unexposed side, as measured by the four thermocouples, to reach 250°F above ambient temperature or (2) any individual thermocouple temperature measurement to reach 325°F above ambient temperature. Once either of these two temperatures was reached, the test was concluded and the time measured from the start of the test was recorded. During each test, observations were made of each assembly respecting board deterioration, cracking, distortion and metal component failure.

The evaluations involved two-hour fire endurance tests and three-hour fire endurance tests, as described below.

Two-Hour Tests

Five two-hour fire endurance tests were conducted as described below. In three of the tests, 1" thick glass fiber mat-faced gypsum board was installed in a test section of a conventional shaft wall

assembly, facing layers of paper-faced gypsum board were fastened to the face side of the metal framework. These facing layers are described in more detail hereinbelow.

The resulting assembly positioned in the aforementioned masonry frame formed one wall of a test furnace. The furnace was fired with multiple gas burners positioned such that the yellow luminous flame from each burner impinged on the face of the specimen thereby maintaining a uniform temperature thereover. Furnace temperature was gradually increased according to the standard time temperature curve of ASTM E-119, as shown below.

<u>Time (minutes)</u>	<u>Temp. (°F)</u>
120	1850
180	1925
240	2000

assembly as described above. For comparative purposes, the other two tests were conducted using conventional 1" thick paper-faced gypsum board sold under the trademark SHAFTLINER by Georgia-Pacific Corporation.

In each shaft wall assembly tested, two facing layers (an inner layer and an outer layer) of gypsum board were fastened to the face of the metal framework. These two layers consisted of 1/2" fire-resistant gypsum boards, the core composition of which is set forth below. Two such boards, each having dimensions of 33" x 39", their longest dimensions oriented horizontally, were fastened to the face side of the framework using 1" Type S screws, 24" O.C. to form an inner facing layer. The joint formed between the edges of these two boards extended horizontally and was not finished. The outer facing layer consisted of a single gypsum board having dimensions of 39" x 66", the longest board dimension being vertically oriented. The board was fastened over the boards of the inner facing layer using 1 5/8" Type S screws, 16" O.C.

The aforementioned 1/2" fire-resistant gypsum boards that were used in the tests are sold by Georgia-Pacific Corporation under the trademark FIRESTOP, Type "XXX". Such boards have a density of about 48 lbs./cu.ft. and comprise a set core from the following composition.

Ingredients

Wt.% based on total
weight of ingredients
prior to addition of
mixing water

finely ground calcium sulfate hemihydrate	94.67
clay (aluminum silicate)	2.59
unexpanded vermiculite	1.10
glass fiber roving, 1/2" chopped glass fiber roving	0.44
core adhesive	0.52
dispersing agent	0.10
foaming agent	0.06
accelerator	0.52
	<u>100.00</u>

In three of the two-hour tests that were conducted, the shaft side of each assembly was exposed to the gas flame inside the furnace. The face side of the tested assembly faced outside the furnace and was not exposed to flame. Table 1 below includes a description of the 1" boards that were used in the shaft wall assemblies that were tested and the fire endurance rating for each of the tested assemblies.

The glass fiber mat-faced gypsum boards referred to in Table 1 below, that is, those boards falling within the scope of the present invention, were made utilizing nonwoven mat composed of glass fiber filaments oriented in a random pattern bonded together by an adhesive referred to by the manufacturer as a "modified urea-formaldehyde resin". The mat had a thickness of 33 mils, and was more porous than paper of the type used as the cover sheet of gypsum wallboard. The air permeability of the mat was 700 CFM/sq.ft. (test method FG 436-910). The mat is available commercially as DURA-GLASS 7502-2 lbs and is an example of a preferred fibrous mat for use in the practice of the present invention. Continuous length board was made from an aqueous slurry of the gypsum formulations described in Table 1 below on a conventional wallboard machine. The slurry was fed onto a moving sheet of the mat as it was unrolled from a roll onto a moving support surface. The mat had a width of about 51 inches and was scored continuously by conventional scoring blades prior to the deposition of the slurry thereon. Each edge of the mat was scored with two score marks, with each of

the outer scores being about 1 inch from its respective edge of the mat and each of the inner scores being about 1 1/2" from its respective edge. After the slurry was deposited on the mat, the edges were folded at the score marks and overlapped on top of the slurry. (The gypsum core formed from this operation had a width of 47 7/8" and a thickness of 1/2".) Mat from another roll thereof and having a width of 47 1/2" was fed onto the top of the gypsum slurry and the overlapped edge portions of the underlying mat. The gypsum slurry penetrated the overlapped edge portions and served to bond the edge portions of the overlying mat to the overlapped edge portions of the underlying mat. The viscosity of the gypsum slurry was about 5900 cp at 70°F. At this viscosity, the slurry penetrated substantially through some portions of the underlying mat to form a thin film thereof on about 40 to 50% of the area of the outer surface of the mat. As the gypsum in the film set, substantial portions of the outer surface of the mat were covered with a thin film of set gypsum. The surface had a roughened appearance with outlines of the glass filaments being observable underneath the thin coatings of gypsum which covered them. However, at the aforementioned viscosity, the slurry penetrated but a portion (about 5 mils) of the thickness of the overlying mat over the entire area thereof, with no slurry being observed on the outer surface of the mat. As the gypsum set in the intermediate portions of the mat that were penetrated by the slurry, it formed a bond that included a mechanical interlock with the set gypsum core.

The continuous length board is cut into lengths of about 8 feet. Drying of the gypsum board is accelerated by heating in an oven at 350°F for about 2 hours and until the board is almost dry and then at 200°F for about 1 hour until it is dried completely.

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TABLE 1

	TEST 1 glass fiber mat-faced gypsum board, <u>Board G-1</u>	TEST 2 glass fiber mat-faced gypsum board, <u>Board G-2</u>	TEST 3 paper-faced gypsum board, <u>Board P</u>
calcium sulfate dihydrate			
glass fiber (lbs/1000 ft. ²)	2.18 (0.056 wt%)	2.18 (0.065 wt%)	5.9 (0.15 wt%)
paper fiber (lbs/1000 ft. ²)	19.45*	19.45*	1.0*
board thickness (inches)	1.023	1.081	0.963
density (lbs/ft.)	45	37	50
board weight (lbs/1000 ft. ²)	3875	3348	4015
fire endurance (hours)	2.0	1.92	1.82

*The difference in paper fiber content is primarily due to the slurry viscosity control function which the fibers perform in regulating the degree of slurry penetration into the glass fiber mats.

Calculations show that the cores of glass fiber mat-faced gypsum Boards G-1 and G-2 contain 63% less glass fiber than the core of Board P, that is, the conventional paper-faced board. Although Board G-1 is 10% less dense than the conventional board, the shaft wall assembly containing Board G-1 showed a 9% improvement in fire endurance over the assembly which included Board P. Although Board G-2 is 17.5% lighter in weight and 26% less dense than Board P, the shaft wall assembly including Board G-2 showed a 5% improvement in fire endurance over the assembly including the conventional board. Thus, even though Boards G-1 and G-2 contained less glass

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fibers in their cores and were less dense than the conventional paper-faced board, test assemblies including the former boards showed an average 7% improvement in fire endurance over the assembly which included Board P.

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In contrast to the previous three tests; the following two tests were conducted on shaft assemblies in which the face side of the assembly was exposed to the gas flame inside the furnace; the shaft side faced outside the furnace and was not exposed to flame. Table 2 below includes a description of the 1" boards that were used in the shaft wall assemblies that were tested and the fire endurance rating for each of the tested assemblies.

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TABLE 2

	TEST 4 glass fiber mat-faced gypsum board, Board G-3	TEST 5 paper-faced gypsum board, Board P-1
calcium sulfate dihydrate		
glass fiber (lbs/1000 ft. ²)	2.18 (0.06 wt%)	5.9 (0.15 wt%)
paper fiber (lbs/1000 ft. ²)	19.45	1.0
board thickness (inches)	1.086	0.977
density (lbs/ft. ³)	39	48
board weight (lbs/1000 ft. ²)	3534	3981
fire endurance (hours)	2.32	2.0

Calculations show that the core of Board G-3 contains 63% less glass fiber than the core of Board P-1, that Board G-3 is 11% lighter in weight than Board P-1 and is 20% less dense than Board P-1. Nevertheless, the shaft wall assembly including Board G-3 showed a 14% improvement in fire endurance over the assembly including Board P-1.

35 Three-Hour Test

40 A three-hour fire endurance test was conducted as described below. A 1" thick glass fiber mat-faced board having a density of 42 lbs/ft.³ was installed in a test section of a conventional shaft wall assembly as described earlier. The core composition of the board, referred to herein as G-4, is set forth below.

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<u>Constituents</u>	<u>Wt.% of Set & dried Composition</u>	<u>lbs/1000 ft.² of set & dried Composition</u>
calcium sulfate dihydrate	99.081	3388.6
glass fiber (1/2" glass fiber roving)	0.063	2.2
paper fiber (sulfite)	0.561	19.2
dispersing agent (lignosite)	0.226	7.7
commercial retarder	0.021	0.7
foaming agent (ammonium lauryl sulfonate, "Micro Foam CP")	0.048	1.6

The face side of the assembly which was tested included three facing layers of conventional gypsum board having a thickness of 5/8" and a core composition as set forth below. The innermost facing layer was formed from two such boards having respective dimensions of 15" x 66" and 24" x 66", their longest dimensions oriented vertically. These boards were fastened to the short legs of the J-tracks and I-stud flanges using 1" Type S screws, 24" O.C. The joint formed between the edges of these boards was centered over the I-stud. The joint was not finished. The boards forming the intermediate and outer facing layers had

the same length and width dimensions and were positioned in the same orientation as the inner and outer facing layers of the assembly described above for the two-hour tests. The outermost facing layer was fastened in place using 2 1/4" Type S screws. The face side of the test assembly was exposed to the gas flames of the furnace, the shaft side remaining unexposed to flames.

The paper-faced gypsum boards were Type "X" board sold by Georgia-Pacific Corporation under the trademark FIRESTOP. These facing boards have an average weight of 2350 lbs/1000 ft.² and a core composition as set forth below.

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<u>Component</u>	<u>lbs/1000 ft²</u>	<u>wt. %</u>
glass fiber (chopped glass roving)	5.0 (minimum)	0.12
core adhesive	13.0 (maximum)	0.53
dispersant	12.0 (maximum)	0.54
foaming agent	as necessary to achieve minimum dry weight.	
accelerator	as necessary to achieve a slurry setting time of 4 to 5 minutes.	
gypsum	board weight less the total weight of additives and a paper cover sheet weight of 120 lbs/1000 ft. ²	

During the test, the temperature of the flame-exposed face of the assembly rose at a rate of approximately 88°F/minute in the first 15 minutes of the test, 9°F/minute in the second 15 minutes, and 1.8°F/minute for the remaining two hours and forty-five minutes of the test, and reached an average temperature after three hours and fifteen minutes of about 1,910°F. The average temperature measured on the unexposed face side of the assembly rose from approximately 77°F (ambient temperature) to 327°F over a period of time of three hours, thirteen minutes. The maximum temperature measured on the unexposed face side was 402°F. It was reached in three hours and twelve minutes. Thus, a fire endurance of 3.2 hours was achieved by the test assembly. There was no indication at any time during the test of pending integrity failure, as would have been manifested by the development of cracks or distortion, of either the furnace-exposed glass fiber mat-faced board or facing boards. The I-stud showed some evidence of buckling after three hours.

It is noted that, in conventional three-hour rated shaft wall assemblies, a 3/4" Type "X" gypsum board is positioned in the assembly in the same manner as the 1" glass fiber mat-faced board de-

scribed herein, and four layers of 5/8" Type "X" FIRESTOP board are applied to the face of the assembly, there being a space maintained between the third and outermost fourth layer of board. Thus, even though the glass mat-faced gypsum board described herein was but 1/4" thicker than the conventional paper-faced board, the shaft assembly with Board G-4 included only three facing layers - (instead of 4) of 5/8" Type "X" FIRESTOP board to achieve a fire endurance of better than three hours.

It will be appreciated from the above described tests that glass fiber mat-faced gypsum boards as described herein, when tested in shaft wall assemblies, show significant improvements in fire endurance over their conventional paper-faced counterparts despite the fact that their cores are significantly less dense and contain a significantly smaller quantity of fire-resistant additives, namely glass fibers.

The next example involves the evaluation in a fire test of a 5/8" thick glass fiber mat-faced gypsum board having a core composition as set forth below and prepared according to the techniques described for glass fiber mat-faced gypsum boards of the earlier examples herein.

ComponentsWt.%, set & dried board

glass fiber mat facing	1.58
calcium sulfate dihydrate	94.06
glass fiber (1/2" chopped glass roving)	0.08
paper fiber	0.74
potash (accelerator)	0.15
wax-asphalt emulsion	2.96
poly(vinyl alcohol)	0.28
calcium lingosulfonate (dispersing agent)	0.11
ammonium lauryl sulfonate (foaming agent)	0.04

The density of the core of the board was 53 lbs/cu.ft. A fire rating of 1 hour and 30 seconds was achieved when the board was evaluated for fire resistance and hose stream resistance according to ASTM E-119. It is noted that the board has excellent water-resistant properties due to the use of water-resistant additives in its core, those additives being wax-asphalt emulsion and poly(vinyl alcohol).

The aforementioned examples well illustrate the excellent fire-resistant characteristics possessed by the development of the present invention. In the examples and other portions of the description of the invention, reference has been made specifically to a shaft wall assembly including metal framework of particular design. It should be understood that fibrous mat-faced gypsum board as described herein can be used in other types of shaft wall assemblies, including assemblies made from other types of fire-resistant materials, for example, fire-resistant plastics. It is noted also that the compositions of the examples included the use of calcium sulfate hemihydrate to form the set gypsum product. Alternatively, there can be used calcium sulfate, the term used in the claims to cover generically both calcium sulfate and calcium sulfate hemihydrate.

In summary, it can be said that the present invention provides in a practical way important functional improvements in structural assemblies which are intended to have fire-resistant properties designed to ensure the safety of life and property.

Claims

1. In a shaft wall assembly comprising fire-resistant framework and gypsum board supported by said framework, the improvement comprising gypsum board which is faced with fibrous mat.

2. An assembly in accordance with Claim 1 including fibrous mat-faced gypsum board having a core which includes mineral fibers in an amount sufficient to improve the fire-resistant properties of the board.

3. An assembly in accordance with Claim 2 wherein said assembly includes glass mat-faced gypsum board having a core which includes glass fibers and wherein said framework is metal.

4. An assembly in accordance with Claim 3 including shaft liner panels and facing panels, wherein said shaft liner panels comprise said gypsum board.

5. An assembly in accordance with Claim 4 in which at least some of said facing panels comprise glass mat-faced gypsum board.

6. An assembly in accordance with Claim 1 and of the type which includes horizontally disposed metal J-tracks spaced from each other and vertically disposed metal I-tracks positioned between said spaced J-tracks, and including panels on the shaft side of the assembly and spaced therefrom panels on the opposite side of the assembly, the panels on said shaft side comprising glass fiber mat-faced gypsum board.

7. Fibrous mat-faced gypsum board having a core which includes one or more additives which are effective in improving the fire-resistant characteristics of the board.

8. Board according to Claim 7 including mineral fibers.

9. Board according to Claim 7 including glass fibers.

10. Glass mat-faced gypsum board having a core which includes glass fibers in an amount sufficient to improve the fire-resistant properties of the board.

11. Board according to Claim 10 wherein said core is the set product of a mixture comprising calcium sulfate and at least about 0.03 wt.% of glass fibers.

12. Board according to Claim 11 wherein said mixture comprises about 0.03 to about 0.3 wt.% of glass fibers.

13. Board according to Claim 12 wherein said mixture comprises about 0.07 to about 0.2 wt.% of glass fibers.

14. Board according to Claim 10, 11, 12, or 13 wherein said core has a density of no greater than about 47 lbs/cu.ft.

15. Board according to Claim 14 wherein said core has a density of about 40 to about 47 lbs/cu.ft.

16. Board according to Claim 15 wherein said core has a density of about 41 to about 45 lbs/cu.ft.

17. Board according to Claim 10 having a core comprising the set product of a mixture comprising calcium sulfate and at least about 0.03 wt.% of glass fibers, said core having a density ranging from about 41 to about 47 lbs/cu.ft., and the amounts and proportions of ingredients comprising the core being such that when said board has a thickness of about 1 inch, a shaft wall test section including said one-inch board has a fire endurance rating of at least about three hours.

18. Board according to Claim 17 having a thickness of about 1 inch.

19. Board according to Claim 17 having a thickness of about 3/4".

20. Board according to Claim 17 having a thickness of about 5/8".

21. Board according to Claim 17 wherein said board has a thickness of about 1 inch, wherein said mixture comprises about 0.03 to about 0.3 wt.% glass fibers and wherein said core has a density of about 41 to about 45 lbs/cu.ft.

22. Board according to Claim 7 having a core which includes also a water-resistant additive in an amount sufficient to improve the water-resistant properties of the core.

23. An assembly according to Claim 6 wherein said shaft side panels comprise gypsum board according to Claim 17 and said opposite side panels comprise paper-faced fire-resistant gypsum board.

24. A shaft wall assembly comprising metal framework and supported by said framework glass mat-faced gypsum board according to Claim 11, 12, or 13.

25. A shaft wall assembly comprising metal framework and supported by said framework glass mat-faced gypsum board according to Claim 14.

26. Gypsum board comprising a set gypsum core sandwiched between two sheets of porous glass mat, each of which has an inner and outer surface, said mat comprising randomly distributed

glass fibers bonded by an adhesive material, the inner surface of each of said mats adhered to said gypsum core by a portion of the set gypsum comprising said core, the outer surface of one of said mats having portions thereof coated with set gypsum comprising portions of the set gypsum of said core and the outer surface of the other of said mats being substantially free of set gypsum, the core including one or more additives which are effective in improving the fire resistance properties of the board in an amount sufficient to impart to the board improved fire resistance properties.

27. Gypsum board comprising a set gypsum core sandwiched between two sheets of porous glass mat, each of which has an inner and outer surface and a predetermined thickness, said mat comprising randomly distributed glass fibers bonded by an adhesive material, the inner surface of each of said mats adhered to said gypsum core by set gypsum of said core penetrating but part-way into the thickness of each of said mats, and wherein the outer surface of each of said mats is substantially free of set gypsum, the core including one or more additives which are effective in improving the fire resistance properties of the board in an amount sufficient to impart to the board improved fire resistance properties.

28. Board according to Claim 22 wherein the water resistance of said core is such that it absorbs less than about 10% water when tested in accordance with ASTM method C-473.

29. Board according to Claim 22 wherein the density of said core is about 48 to about 55 lbs/cu.ft.

30. Board according to Claim 22 wherein said core is the set product of a composition comprising about 3 to about 10 wt.% of wax-asphalt emulsion.

31. Board according to Claim 22 wherein said core is the set product of a composition comprising at least about 0.05 wt.% poly(vinyl alcohol) and at least about 2 wt.% of wax-asphalt emulsion.

32. Board according to Claim 31 having a thickness of about 5/8" and a core having a density of about 48 to about 55 lbs/cu.ft., wherein the fire-resistant properties of the board are such that at least a one-hour rating is achieved according to ASTM E-119.

33. A structural assembly having improved sound-reducing transmitting properties comprising gypsum board according to Claim 7 and facing material adhesively attached thereto.

34. As assembly according to Claim 33 wherein said board is faced with glass mat.

35. Board according to Claim 28 wherein the water resistance of said core is such that it absorbs less than about 7.5% water when tested in accordance with ASTM method C-473.

36. Board according to Claim 35 wherein the water resistance of said core is such that it absorbs less than about 5% water when tested in accordance with ASTM method C-473.

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Water-soluble/film-forming
polymer or copolymer

FIG. 1.

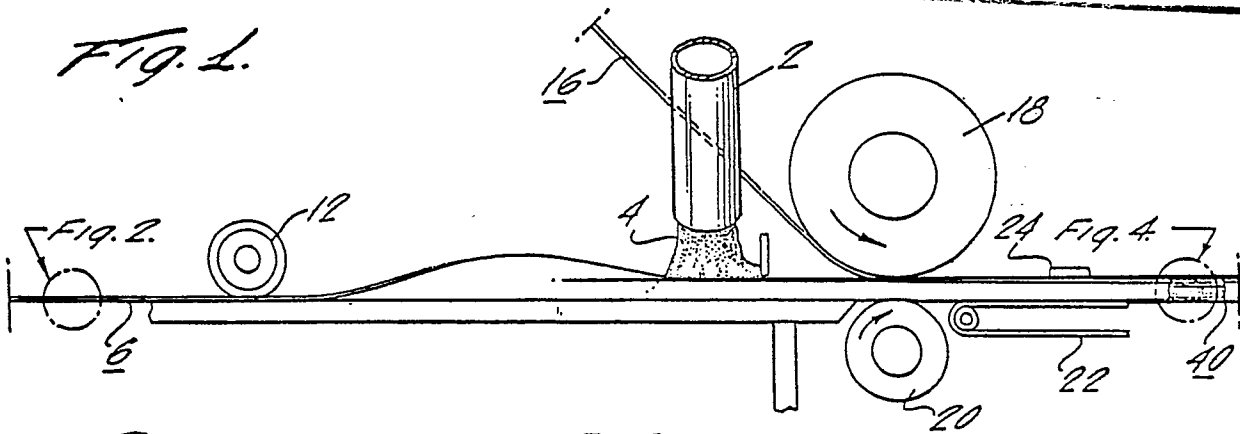


FIG. 3.

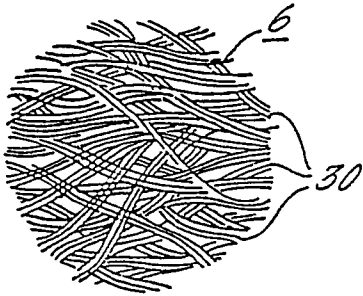


FIG. 5.

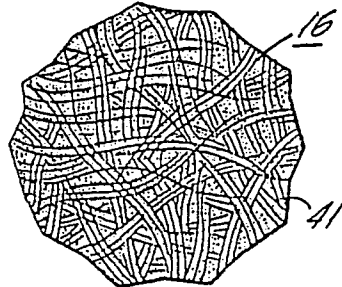


FIG. 8.



FIG. 2.

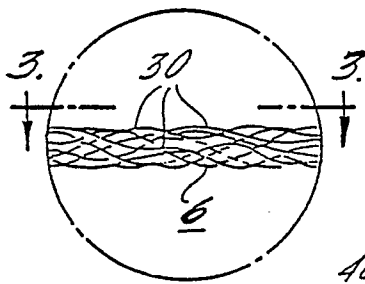


FIG. 4.

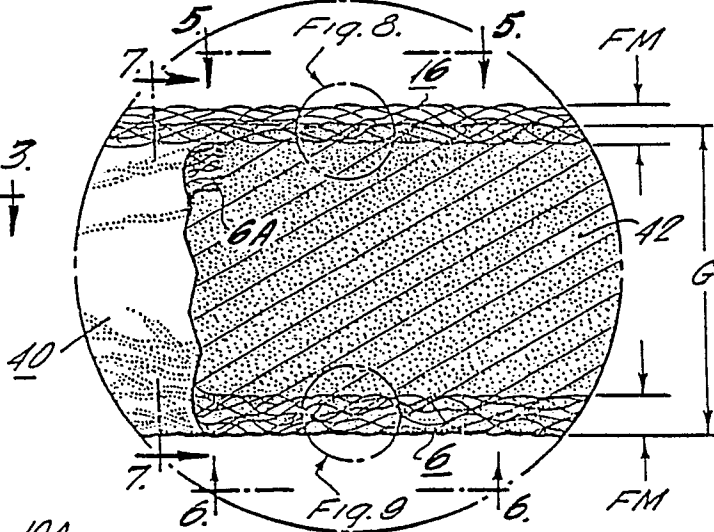


FIG. 7.

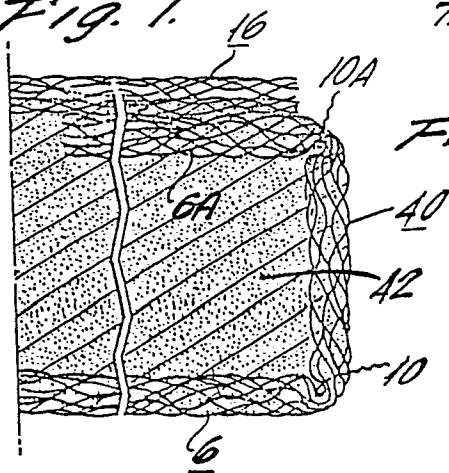


FIG. 6.

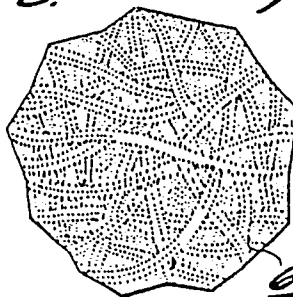


FIG. 9.

