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STRUCTURAL MEMBER WITH MUTI-LAYERED GYPSUM BOARD FIRE PROTECTION

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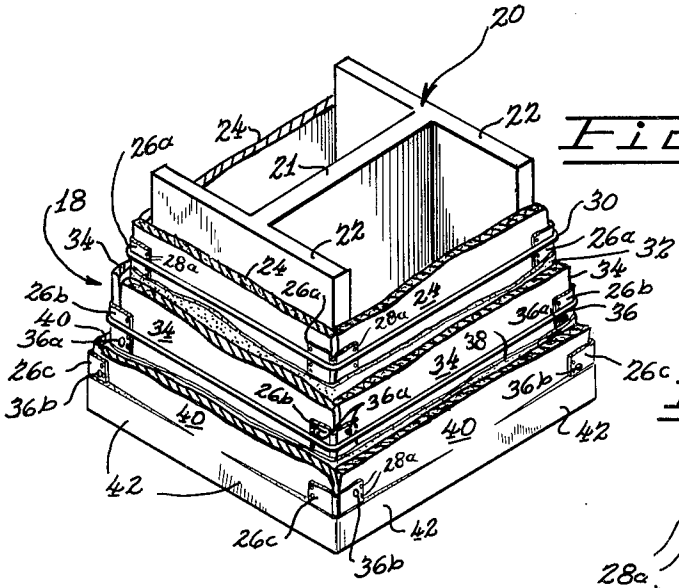


Fig 1

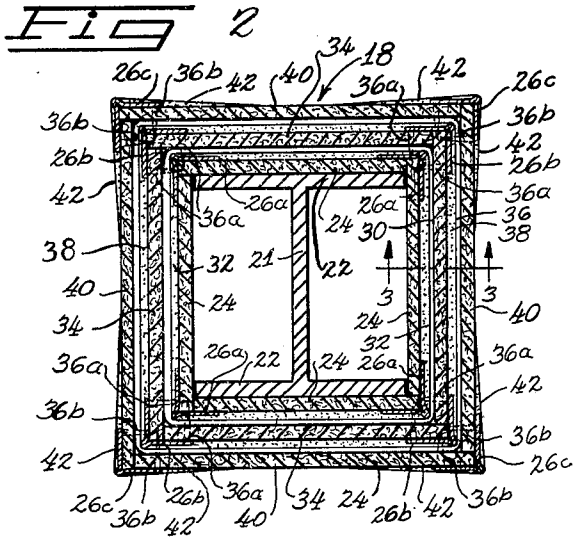


Fig 2

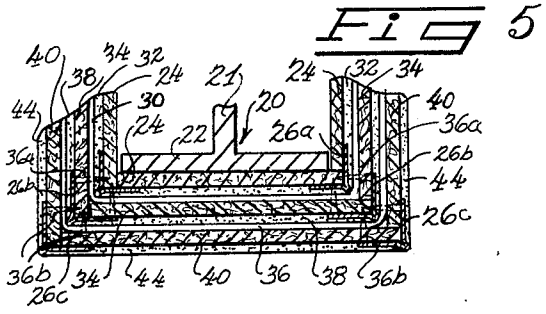


Fig 5

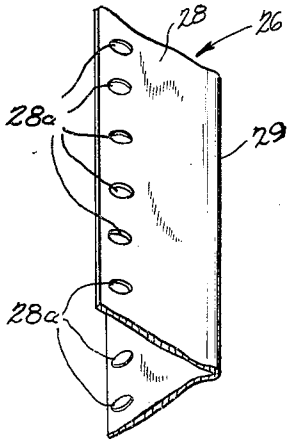


Fig 4

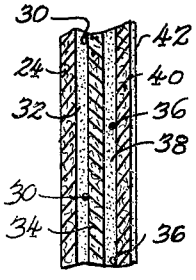


Fig 3

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STRUCTURAL MEMBER WITH MULTI-LAYERED GYPSUM BOARD FIRE PROTECTION

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1 Claim. (Cl. 52—423)

This invention pertains to fire resistant building constructions and more particularly to gypsum board coverings for retarding the effects of fire upon structural elements.

One important criterion in building constructions is the ability of the structure to withstand the effects of fire. Acceptable structures must be capable of retaining their structural integrity for a substantial period of time even through subjected to an internal or external conflagration. This quality of a structure and/or its components to withstand fire conditions is commonly known as its "fire rating" and is measured in increments of time signifying the period for which the construction will maintain prescribed parameters, such as temperature, strength, or non-combustion of the components, under specified test conditions. One accepted standard for fire endurance ratings of the type of element to which this invention pertains is Underwriters' Laboratories, Inc. test "Standard for Fire Tests of Building Construction and Materials" UL 263 (NFA 251, ATSM E 119). Fire ratings discussed hereinafter will be with reference to such a standard, except as may otherwise be noted.

An extremely important aspect of providing a satisfactory fire enduring building construction is the protection of the main frame members and particularly the support columns. The present invention will be disclosed and described herein with reference to this use and more particularly with reference to the fire protection of steel columns such as are used in many commercial type buildings.

When utilizing steel structural members it is normally necessary to protect them with coverings of suitable materials, such as gypsum panels, plaster, Portland cement concrete, or the like, to meet building code fire ratings which are usually prescribed by local authorities. Such codes normally require a minimum rating of two hours according to a standard fire endurance test such as that noted above. This however is merely a minimum rating required for approval of the construction. Notwithstanding the fairly common acceptance of a two hour rated construction by local authorities, an important reason for obtaining even higher fire ratings has arisen from the present and increasing demand by insurance underwriters that structural members be sufficiently protected to achieve a minimum fire rating of three hours as added protection against fire losses.

Along with the requirements for high fire ratings, there remains the ever present necessity for economy of time and materials in building constructions. Consequently it is highly desirable that high fire ratings be obtained with constructions which may be easily and simply formed without the provision of special equipment and/or materials or the application of special skills.

The present invention provides an advantageous approach to the aforenoted problems by obtaining a high fire rating with components which are commonly utilized in so-called drywall interior constructions and are thus readily available. This, in turn facilitates erection and completion of a building as all interior constructions, including fire protection members, may be fabricated of the drywall components.

It is an object of this invention to provide an improved fire enduring covering of gypsum board panels for structural members, utilizing a minimum number of layers of panels to achieve maximum fire endurance ratings.

It is another object of this invention to provide improved fire enduring coverings for structural members which obtain high fire ratings and which may be conveniently and economically included in a building construction.

Further and additional objects and advantages will appear from the following description, accompanying drawings and appended claims.

In carrying out this invention in one illustrative form, a structural member is encased in superimposed layers of gypsum board panels, the panels of each layer forming joints where the edges of the panels meet, with an incombustile cover member secured over each of these joints. Adhesive material such as joint compound bonds each overlying layer of panels to the subjacent panels, and wire binding members extend around each layer of panels and the respective cover members, except the outermost layer. Additional joint compound is applied to and finishes the exterior surface of the outer layer of panels.

For a more complete understanding of this invention, reference should now be had to the example illustrated in the accompanying drawings wherein:

FIG. 1 is a perspective view of a structural member with a fire protective covering employing the teachings of this invention, the encasing covering being partially broken away;

FIG. 2 is a horizontal cross-sectional view of the construction in FIG. 1;

FIG. 3 is a partial cross-sectional view taken along lines 3—3 of FIG. 2 and looking in the direction of the arrows;

FIG. 4 is an enlarged perspective view of a portion of one of the joint cover members utilized in the construction of FIG. 1, and

FIG. 5 is a partial cross-sectional view similar to FIG. 2 but illustrating an alternate surface treatment.

Referring now to the drawings, and more particularly to FIGS. 1, 2 and 3, a fire protective construction **18** is disclosed as applied to and enclosing a steel I-beam column **20** comprising a web **21** and flanges **22**.

The column-encasing fire protective construction **18** includes a first layer of gypsum board panels **24** arranged around and enclosing the member **20** over its full exposed length. When the structural member **20** is of a rectangular peripheral configuration as illustrated, the panels **24** may be of a width greater than the corresponding sides of the structural member by an amount equal to the panel thickness, whereby the panels fit snugly against the member and form neat, closed, overlap joints at each corner. Cover members **26***a* of an incombustible material are then placed over each of the corners and cover the joints between the panels **24**.

The angle members **26**, illustrated in FIG. 4 (**26***a*, *b* and *c* in the remaining figures) each comprise a metal angle having a pair of angularly disposed flanges **28** joined by a bulbous arcuate ridge or bead **29** which projects outward of the planes defined by flanges **28**. The bead **29** facilitates placement of the flanges against the panel edges regardless of such slight irregularities as may occur at the corners of the panels **24** and may serve as a ground for applying other materials such as joint compound. Holes may be formed in the flanges as at **28***a* whereby plastic joint compound placed over the members **26** will pass through the holes, bond to the edges of subjacent panels and key the resulting structure together.

When two or more artisens cooperate in applying the components of this construction to a structural member, the angle members **26***a* need not be secured to the edges

of the panels since the artisans can cooperate and maintain them in place until subsequent holding structure is applied. However, when a single artisan applies the components, it is convenient to tack or nail these angles to the panels for temporary holding purposes.

Flexible binding members **30** are next placed around the first layer of panels **24** and the cooperating angles **26***a* at spaced intervals over the length of member **20**. The binding members, which are of incombustible materials and preferably comprise steel wires, are drawn snug and tied or otherwise suitably secured.

A layer of cement **32** is applied to the exposed surface of each of the panels **24**, prior to the application of the next layer of panels. The cement **32** should be distributed over substantially the entire exposed surface of the panels **24**, and be of a depth to extend outward flush with or beyond the outer surface of the binding members **30**. This may be accomplished by trowelling on a smooth continuous layer of cement, or by utilizing a notched trowel to form spaced ridges of the requisite height, or the cement may be otherwise distributed in a continuous or discontinuous layer, so long as the resulting cement layer contacts the adjacent panels over substantially the entire area of their opposed surfaces after the overlying layer of panels **34** is pressed into place.

The second layer of panels comprising gypsum board panels **34** is then applied over the previously assembled structure, the panels **34** also being of a width to form overlap joints at each corner. The panels of this second layer will normally be held in position by the cement **32** previously applied to the exposed surface of the first layer of the panels. Angle cover members **26***b* are placed over the corners of panels **34** to cover the joints therebetween and are secured in position by driving suitable fasteners **36***a*, such as metal screws, through the flanges of the angles **26***b*, through the underlying edges of panels **34** and through the flanges of the underlying angle members **26***a*. Flexible binding members **36**, similar to members **30**, are placed around the panels **34** and corner members **26***b*, drawn snug and secured, and a layer of cement **38** is distributed over the exposed surface of the panels **34** of this second layer in the same manner described above regarding cement layer **32**.

Additional intermediate layers, such as the second layer of panels and related angle members, binding members and cement, may be applied in the same manner as the second layer.

The surface or finish layer construction is formed of panels **40** which are cut and applied to form overlapping edge joints as in the preceding layers. Corner members **26***c* are then applied over the corners in the same manner as the corner members **26***b* of the second layer, the corner members **26***c* being secured in place by fasteners **36***b* extending through the flanges thereof, through the edges of the underlying panels **40** and through the flanges of the underlying corner members **26***b*. The flanges of corner members **26***c* are then covered with joint cement **42** flush with the beads **29** of these members, and the cement feathered out over the panels **40** to provide a smooth planar appearing surface. The final layer of cement **42** provides a finished appearing surface to receive suitable decorative materials where desired.

The alternative construction illustrated in FIG. 5 is the same as that illustrated and described with reference to FIGS. 1–3 except that the final exposed layer of cement **44** covers the panels **40** to the depth of the beads **29** of the angle members **26***c* and provides the finished appearing external surface.

The cement utilized to adhere the various panels together and to finish and/or cover the external surface of the outer layer may preferably be a joint compound, such as a casein or polyvinyl acetate base with a suitable filler, sometimes referred to as joint cement in the drywall industry. By way of example, suitable joint compounds are discussed in U.S. Letters Patent No. 3,003,979 to Ptasienski and Gill, and No. 2,047,982 to Page.

By way of one specific illustration of a construction embodying this invention, a steel column was covered in accordance with the disclosure in FIG. 5 utilizing panels about 5/8" in thickness and comprising paper covered cores of set calcined gypsum meeting Underwriters' Laboratories, Inc., classification "Wallboard, Gypsum" Guide No. 40 U 18.23, and sold under the trademark "Firecode" by United States Gypsum Company, Chicago, Illinois. The binding members were 18-gauge double strand steel wires of circular cross section, distributed over the length of the column at a maximum spacing of about 21" apart, and with a maximum spacing of about 6" from each end of the construction. The cover members were angular corner members of 26 gauge (U.S. Standard) galvanized steel with each flange being about 1" in width. The fasteners extending between pairs of overlying joint covering members were threaded, self-tapping rotary drywall metal fasteners of the type described in U.S. Letters Patent No. 3,056,234 to Nelsson and Knohl, about 1" in length, and placed on 12" centers along each cover flange. Joint compound sold under the trademark "Perf-A-Tape" by United States Gypsum Company of Chicago, Illinois, was utilized between successive panel layers and spread with a notched spreader to leave lines or rows of compound which were semicircular in cross section, with diameters of about 3/8", and on about 1 1/8" centers; this resulted in a compound bonding layer about 1/16" thick after the overlying panels were secured in position. The outer surface finishing layer was also joint compound about 1/16" thick.

When tested according to the aforenoted Underwriters' Laboratories, Inc., test, the construction described above provided a fire rating of about 3 hours and 33 minutes.

The importance of the combination of features disclosed and claimed herein can perhaps best be illustrated by comparison of the fire rating test results on the foregoing example with the results of tests on other structures. For instance in three National Bureau of Standards tests on steel columns protected by layers of 1/2" thick gypsum board panels and joint compound between the panel layers, but without the metal corner joint covering members, the following results were obtained:

Test	Construction	Rated, hours.
No. 315—5-22-52—4 layers.	Steel column protected with four layers of 1/2" panels, fit with edge overlap and cut in lengths to cover the column height. Each layer applied vertically with joint compound to bond inner layer to column and successive layers to each other. Tied around the column with double strands of 18 ga. tie wire spaced 15" apart after third layer is in place. Outer corners finished with joint compound and paper tape.	2 1/2
No. 304—5-25-51—3 layers.	Steel column protected with three layers cut and applied as above except first two layers cemented and clinch-nailed together; then tied around column with double strands of 18 ga. tie wire spaced 15" apart. Third layer then applied and outer corners finished with joint compound and paper tape.	1 1/2
No. 303—5-23-51—2 layers.	Steel column protected with two layers cut and applied as in four layer construction above, except inner layer tied around column with double strands of 18 ga. tie wire, spaced 15" apart. Corners of face layer finished with joint compound and paper tape.	1

In other tests utilizing 5/8" thick gypsum board panels as designated above in the specific example of the present invention, together with metal angle corner joint covering

members, but without cement between the panel layers, the following results were obtained under the aforenoted Underwriters' Laboratories tests:

Test	Construction	Rated
1-24-61—4 layers	Steel column protected with four layers of panels fit with edge overlap and cut in engths to cover the column heights. Each layer applied vertically; the first and second layers each tied with ½" high tensile strength .015" thick metal straps spaced 2' apart. Corners of the second, third and fourth layers covered with metal angles, with screws fastening the angles of the third layer to the angles of second, and the fourth to the third. Outer corners and layer finished with joint compound.	About 2 hrs., 33 min.
11-14-60—3 layers	Steel column protected with three layers of panels, tied around the two inner layers similarly to the four layer construction above except with 1'6" spacing from the floor slabs and 2'6" spacing between ties. Corners at the first, second and third layers covered with metal angles, with screws fastening the angles of the second layer to angles of the first layer, and the third to the second. Outer corners finished with joint compound.	About 2 hrs., 33 min.
9-16-60—3 layers	Steel column protected with three layers of panels, tied around the second layer with metal straps as in the four layer construction above except with 1'6" spacing from the floor slabs and 2'6" spacing between ties. Corners at the second and third layers covered with metal angles, with screws fastening the angles of the third layer to the angles of the second. Outer corners and layers finished with joint compound.	About 2 hrs., 25 min.

The fire rating of 3 hours and 33 minutes obtained with the construction according to the previously described specific illustrative embodiment of the present invention was thus one hour longer than the ratings of other laminated panel constructions, even though the other constructions included as many as three, or even four layers of panels.

It will thus be seen that a novel construction has been disclosed and taught which utilizes inexpensive and readily available components to provide an advantageous high fire rating covering for structural elements. Further, the high fire rating constructions of this invention may be fabricated with the same components normally utilized in drywall constructions, thereby permitting the use of the same elements throughout the interior construction of a building and thus further enhancing the simplicity and economy of building construction.

While a particular embodiment of this invention is shown above and illustrated in the specific example, it will be understood, of course, that the invention is not to be limited thereto, since many modifications may be made by those skilled in the art in light of the disclosure and teachings herein. It is contemplated therefore by the appended claim to cover any such modifications as fall within the true spirit and scope of this invention.

We claim:

A fire enduring construction enclosing a structural member, comprising first, second and third successive superimposed layers of panels surrounding such structural member over its full exposed length, each of said panels comprising a paper covered core of set calcined gypsum, said panels of each layer being disposed in edge-overlapping relation forming corners where the edges of adjacent panels meet, said corners of successive layers being juxtaposed, a metal angle corner member secured over each corner of each layer, fastening members securing said cover members over said second and third layers to said cover members over said first and second layers respectively, a plurality of incombustible binding members extending around said panels and cover members of each inner layer and distributed over the length of said construction, and layers of joint compound bonding said panels of said second and third layers to the panels of said first and second layers respectively over substantially their entire area.

References Cited by the Examiner

UNITED STATES PATENTS

646,503	4/1900	O'Shea	52—725 X
2,047,982	7/1936	Page	52—417
2,063,010	12/1936	Balduf	52—241 X
2,267,929	12/1941	Lefebure et al.	52—725
2,797,573	7/1957	Hummer	52—254 X
2,851,741	9/1958	Stemples	52—255
2,969,616	1/1961	Gustafson	52—278 X
3,056,234	10/1962	Nelsson et al.	52—363

OTHER REFERENCES

Architectural Forum (a publication), February 1952, page 22.

Building Materials List, published by Underwriters' Laboratories Inc., January 1961, page 66.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,217,456 November 16, 1965

Paul S. Quigg et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the sheet of drawings, line 2 of the heading, for "MUTI-LAYERED" read -- MULTI-LAYERED --; column 1, line 18, for "through" read -- though --; line 29, for "ATSM" read -- ASTM --; column 2, lines 15 and 16, for "incombustile" read -- incombustible --; line 69, for "artisens" read -- artisans --; column 5, in the table, second column, line 3 thereof, for "engths" read -- lengths --.

Signed and sealed this 13th day of September 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents