Dec. 30, 1941. V. LEFEBURE ET AL 2,267,929

FIRE-RESISTING STRUCTURE

Filed April 21, 1939

Fig. 1.

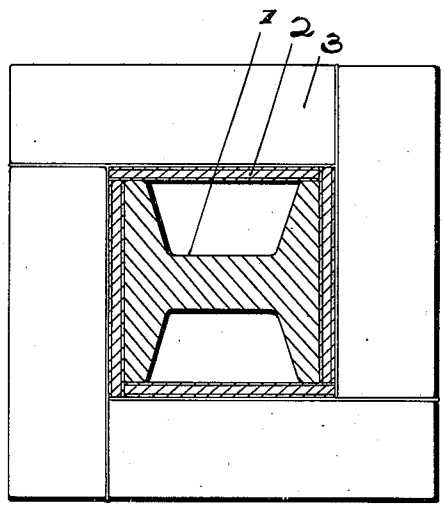


Fig. 2.

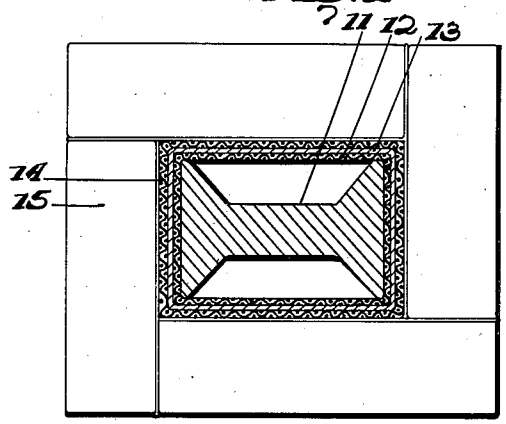


Fig. 3.

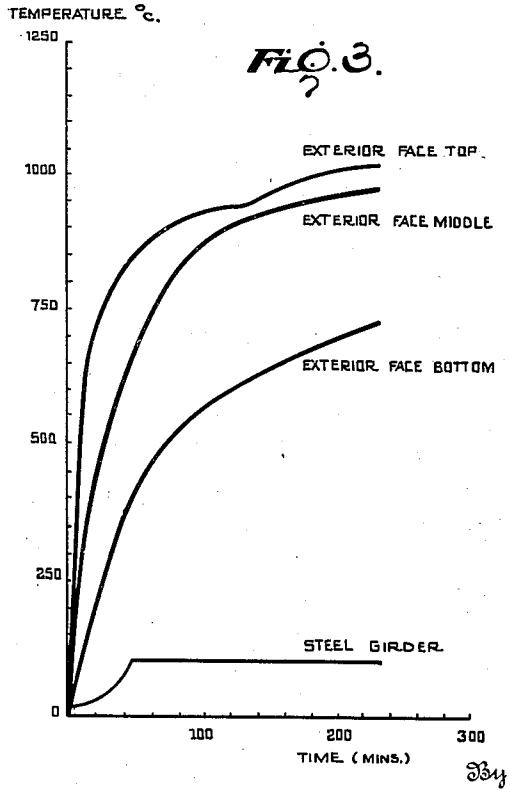
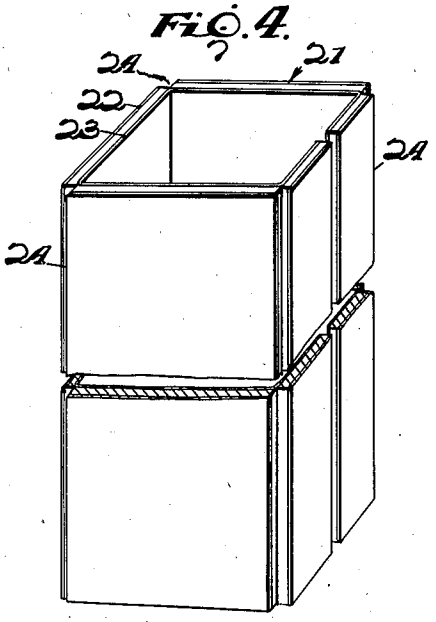


Fig. 4.



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FIRE-RESISTING STRUCTURE

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In Great Britain April 28, 1938

8 Claims. (Cl. 72—74)

It is well known that methods of protection are employed to enable columns or beams in structures to retain their strength in a fire by surrounding them with materials which resist the spread of heat from the exposed faces to the structural members, say steel columns. A common method is to build a column of concrete round the structural member, by the usual method of pouring concrete with the support of shuttering.

Attempts have been made to employ swifter, lower cost and drier methods by erecting narrow block walls round the structural member, thus attempting to use the air-space between such wall and the member as a contribution to the thermal resistance. Such methods are deficient owing to the tendency for the protecting walls, and notably the mortar, to crack, thus allowing flame and hot gases to penetrate beyond the wall and to contact with the member.

This invention has as an object to devise a new method of building fire-proof structures. A further object is to devise a new method of protecting columns and beams from fire. A still further object is to provide new fire-proof structures. Further objects will appear hereinafter. These objects are accomplished by the following invention, according to which a fire-resisting casing for beams and columns in structures is provided which comprises an outer casing of set calcium sulphate plaster (gypsum) of substantial thickness, preferably at least ¾ inch, firmly bonded over the whole of its inner surface to a backing layer of strong fibrous sheet material, other than textile fabric, which forms an inner casing, or a part thereof, and which is separately erected around the member to be protected in such a manner that air spaces of substantial size are formed between portions of the inner casing and portions of the said member.

A satisfactory method of building the inner casing is to use a wall board or plaster board consisting of a core of calcium sulphate between coverings or liners of paper, cardboard, pulp board, or the like which are firmly bonded to the core. This can be shaped to fit round the member, or simply employed as long strips of board. A preferred form consists of two U-shaped sections. These strips or sections are tied to or around the member by means of metal wire or metal ribbon, or other suitable forms of easy attachment. Alternatively, they can be stuck to the member by means of a fire-proof adhesive such as a composition of Portland cement, an alkaline silicate and a retarder such as glue. This method has the advantage of protecting the metal against corrosion. Metal clips can be employed to hold the strips or sections in position, and the corners can be strengthened by means of strips of linen, cotton or other suitable textile material applied with an adhesive. Thus air spaces of substantial size are formed between portions of the inner casing and portions of said member.

Blocks may now be erected around the structure using a bonding material such as plaster, or a fire-proof adhesive such as that mentioned above. We prefer to employ metal strip or similar reinforcement in the bonding material. As the blocks are erected they are not only bonded together, but also bonded to the inner casing.

A simple and satisfactory method of erecting the inner casing is to take a sheet of plaster board and score it in lines along the length of the board, thus marking off rectangles corresponding with the dimensions of the section to be protected. The scoring is through the liner and as deep into the core as possible without harming the bottom liner. The board can then very easily be broken along the lines of the scoring without tearing the back liner. It can then be folded round the member to be protected, forming a box which can easily be handled by one man. The two free edges can be fastened together by any convenient means such as clips, U-shaped nails or adhesive tape. It saves work and gives a very strong structure if the board is so scored that two free edges meet on one of the flanges of the member.

Instead of using rigid sheet material for constructing the inner casing we may use flexible fibrous material such as paper, pulp board, cardboard or the like in conjunction with reinforcement, e. g. wire netting. If desired, the fibrous material may be previously treated with fire-proofing agents, e. g. ammonium phosphate, but this is not essential since the fibrous material is shielded from the effects of fire by the outer casing of gypsum, which produces a temperature gradient such that the temperature on the cold (inner) side is within the safe working limits of the fibrous material.

If we use board it is preferably a plaster board with at least one face composed of a liner which contains asbestos fibre as part of the paper-making fibres. In this way we obtain a fire-resisting junction between the plaster and the core of the plasterboard, thus increasing the stability of the system when subjected to heat. Such a fire-resisting junction can also be ob-

tained by using a plaster-board with a perforated liner. On laying the plaster on such a plasterboard the plaster keys both to the liner and through the perforations to the plaster core so that even if the liner is subjected to sufficient heat to cause it to disintegrate or burn, the blocks will still be bonded to the plaster core. As a bonding material to bond the blocks and to stick them to the rigid backing, we prefer to use a calcium sulphate plaster, say anhydrite plaster or a hemihydrate plaster.

We prefer to employ blocks of void or cellular structure made from plaster of the accelerated anhydrite type or of plaster of Paris. Such blocks can be made from plaster mixes containing foam or suitable gas generating agents, e. g. as described in U. S. Patent No. 2,015,481.

Instead of using blocks we may surround the encased member with plaster cast in situ. Thus the plasterboard next to the member to be protected may be used as shuttering in order to pour calcium sulphate protecting material, using a temporary or permanent outer shuttering, which outer shuttering can be of the same type of board. If it is to be permanent, we prefer to employ the board with at least one liner containing asbestos, this liner contacting with the inner, poured calcium sulphate material. If we wish we can employ this type of board as a further outer casing for the system in which blocks are used instead of poured material as the main fire-resisting element.

The accompanying drawing illustrates two applications of the invention. In these cases the structure to be protected is a steel column. Both Figures 1 and 2 represent a cross-section through the column and the protective structure erected round it. Figure 3 is a graph illustrating the fireproofing test of Example 1. Figure 4 is a broken perspective sketch of a preferred form of the inner casing.

Referring to Figure 1, **1** is the steel column to to be protected; **2** represents an inner casing of ⅜ inch gypsum plasterboard of the type known as baseboard, while **3** represents an outer casing of 2½ inch grooved cellular anhydrite blocks which are bonded to the baseboard and to each other with anhydrite plaster.

Referring to Figure 2, **11** represents the column to be protected, **12** a ¾ inch mesh wire netting strapped in position with ⅜ inch steel ribbon, **13** a 0.03 inch wallboard liner wrapped outside the netting **12**, and **14** another layer of ¾ inch wire netting strapped in position as before. **15** represents the outer casing of 2 inch blocks which are bonded together and to the wallboard liner.

Referring to Figure 4, **21** is a sheet of plasterboard consisting of a core of calcium sulphate plaster between two liners **22** and **23**. This board has been scored along the vertical lines **24**, thus cutting the liner **22** completely and cutting to a certain extent into the core. The board was then bent along the lines **24** so that the core fractured while the liner **23** was undamaged. This sheet could then be wrapped into the form shown in the drawing, in which shape it is intended to surround the member to be protected. It can be held in this position by steel strapping or other means and then the blocks bonded to the outside.

Figure 3 will be further described in Example 1.

The following examples illustrate but do not limit the invention.

Example 1

The object in this example was to protect a girder and the assembly was as illustrated in Figure 1. ⅜ inch gypsum plasterboard **2** of the type known as baseboard was strapped to the steel column **1** to be protected by means of ⅜ inch steel ribbon spaced at intervals of 1½ feet. The girder was a 5 foot x 6 inch x 5 inch standard I section. 2½ inch grooved cellular anhydrite blocks **3** were stuck to the baseboard with anhydrite plaster and were reinforced at the horizontal joints with steel 1 inch x ½ inch web T sections. Anhydrite plaster was used for bonding the block wall and the joints were scrimmed with 4 inch Hessian scrim. Subsequently, the blocks were slurried, i. e. thinly coated, with a wet cement wash, and a finishing coat of anhydrite plaster was applied to them.

The encasement was erected one week before testing and the skimming or finishing coat of plaster was applied 4 days before testing. The unit as described was erected in a suitably designed test chamber which was fitted with two burners placed 3 feet in front of the unit. Using coke oven gas as fuel, a temperature of 950–1000° C. could be maintained at the face of the system.

Sufficient thermocouples were inserted to enable the temperature distribution in the system to be accurately ascertained, and they were placed in the following positions: one set on the external faces of the encasement in immediate contact with the flames, another on the internal faces of the baseboard, and another on the steel girder itself. The temperature could then be read off from suitable indicators.

The duration of the test was for 4 hours and observations of the temperature rise and of the behaviour of the unit were made. The temperature curves are given in Figure 3.

During the 4 hours of the test, the average temperature of the girder did not rise above 115° C., although the temperature of the encasement face was about 1000° C.

To ensure the safety of steelwork it is necessary that it should be kept down to a temperature below 500° C. It will be seen that this particular encasement therefore gives complete protection for at least 4 hours and therefore gives remarkably good fire resistance.

In contrast with this, a 2 inch thick concrete slab attained a temperature of 140° C. on the back face after 30 minutes.

Example 2

This example illustrates the effectiveness of the assembly illustrated in Figure 2.

An encasement was prepared as follows: ¾ inch mesh light wire netting **12** was wrapped once round the column **11** (5 foot x 6 inch x 5 inch) and this was strapped with ⅜ inch steel ribbon at 18 inch intervals. On top of this was wound a single layer of wallboard liner **13**, followed by a second layer of the wire netting **14** which was strapped with steel ribbon. A wall of 2 inch cellular anhydrite block **15** was then built against this construction using a fire resistant anhydrite adhesive to secure the blocks to one another and to the liner and netting. Subsequently, this was finished with a single coat of anhydrite plaster.

The encasement had not failed after 2¼ hours, testing by the standard test, and at that time the average temperature of the girder was 112° C.

Instead of cellular anhydrite blocks, compact anhydrite blocks, cellular or compact hemihydrate blocks may be used. Cellular anhydrite blocks reinforced on both large faces with paper stuck with calcium caseinate (of the type described under U. S. application No. 171,788) may be used with advantage.

We prefer to use blocks having a thickness of at least ¾ inch, which thickness will maintain the temperature of the cold face at below the dehydration temperature of the plaster for several hours for any temperature of the hot face normally met with during a fire.

This invention is of course not limited merely to building protective structures round girders but could equally well be applied to building fireproof walls and the like.

This invention is a valuable advance in the art as the blocks are keyed over a whole surface to a strong backing, so that even if the outer casing cracks pieces will not fall away. This means that no flame can reach the girder until the blocks have almost entirely disintegrated, so that the protective system has a longer life than that of any known system of similar cost.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

We claim:

1. A fire-resisting casing for beams and columns in structures, which comprises an outer casing of set calcium sulphate plaster of at least ¾ inch thickness firmly bonded over the whole of its inner surface to a backing layer of strong non-woven fibrous sheet material, said backing layer forming a box-like inner structure with rectangular sides enclosing the member to be protected and spaced from portions of said member to provide longitudinal air spaces adjacent thereto, the cross-sectional dimensions of said structure being substantially just sufficient to accommodate said member.

2. A fire-resisting casing according to claim 1, in which the inner structure comprises plasterboard having an outer liner which contains asbestos fiber as part of the paper-making fibers.

3. A fire-resisting casing according to claim 1, in which the inner structure comprises plasterboard having an outer liner which is perforated so as to expose the plaster core at a number of places and thereby furnish a key for subsequently-applied plaster.

4. A fire-resisting casing according to claim 1, in which said box-like structure is composed of a plurality of rectangular strips of plasterboard having a plastic core firmly bonded to inner and outer liners of non-woven fibrous sheet material, said strips being united by said inner liner, and said outer liner and core being fractured at the corners of said structure.

5. A fire-resisting casing according to claim 1, in which said box-like structure consists of flexible material belonging to the class consisting of paper, pulp board and cardboard, in conjunction with metal reticulated reinforcement.

6. A fire-resisting casing according to claim 1, in which the outer structure consists of blocks bonded together and to the inner casing.

7. A fire-resisting casing according to claim 1, in which the outer casing consists of blocks bonded together and to the inner casing with a calcium sulphate plaster.

8. A fire-resisting casing according to claim 1, in which the outer casing consists of plaster cast in situ.

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