

Feb. 9, 1943.

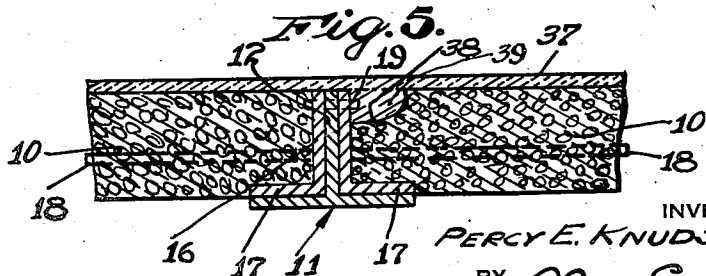
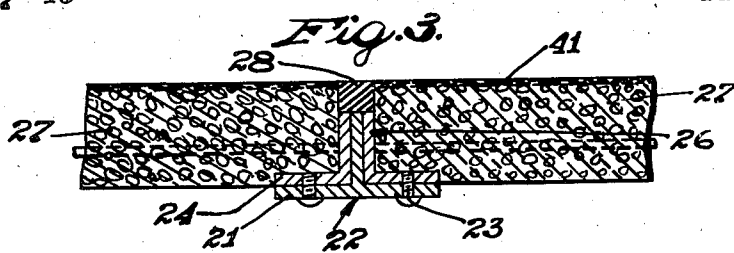
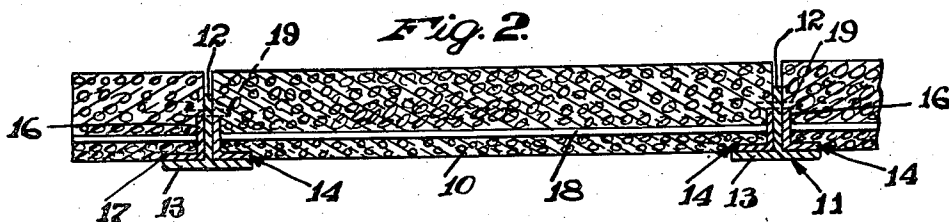
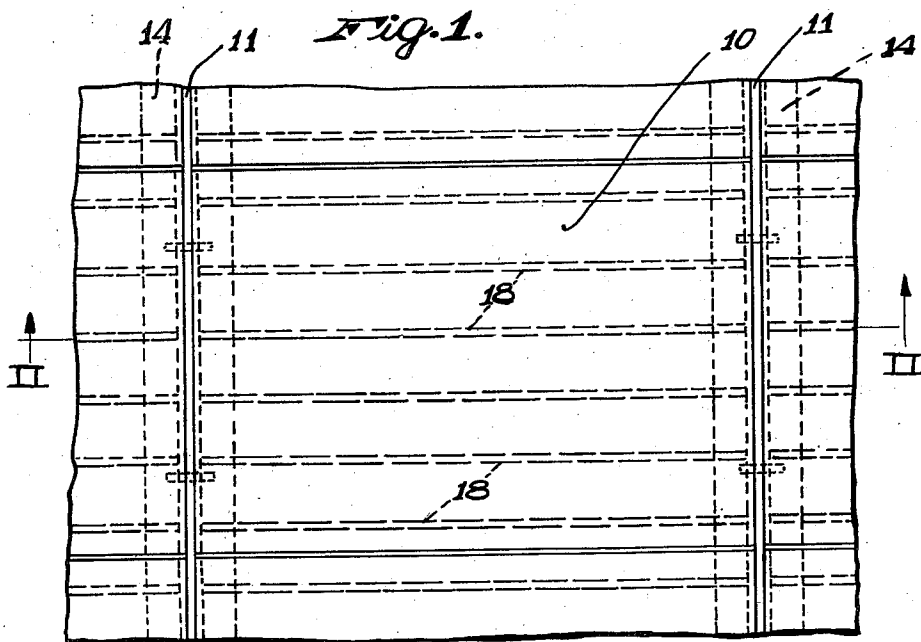
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2,310,442

CELLULAR SLAB

Filed March 24, 1939

3 Sheets-Sheet 1



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Fig. 4.

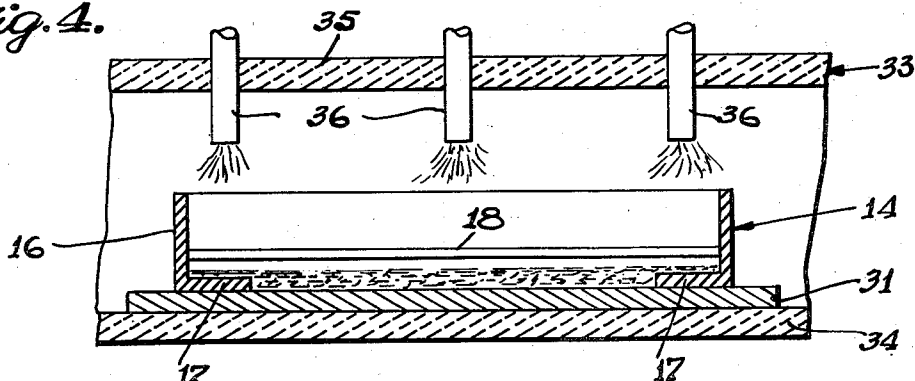


Fig. 6.

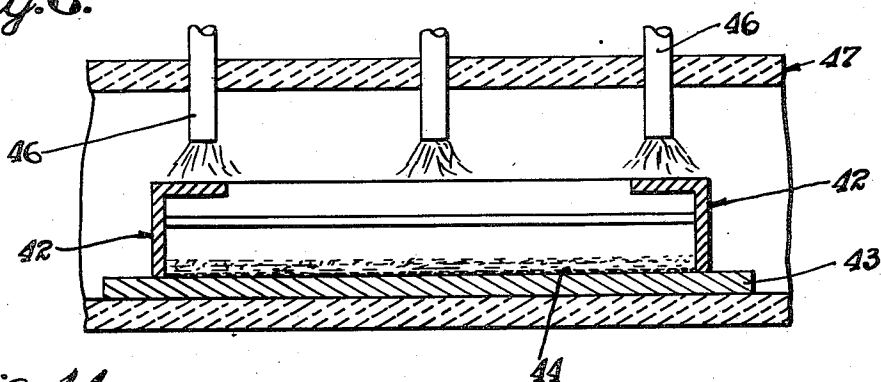


Fig. 11.

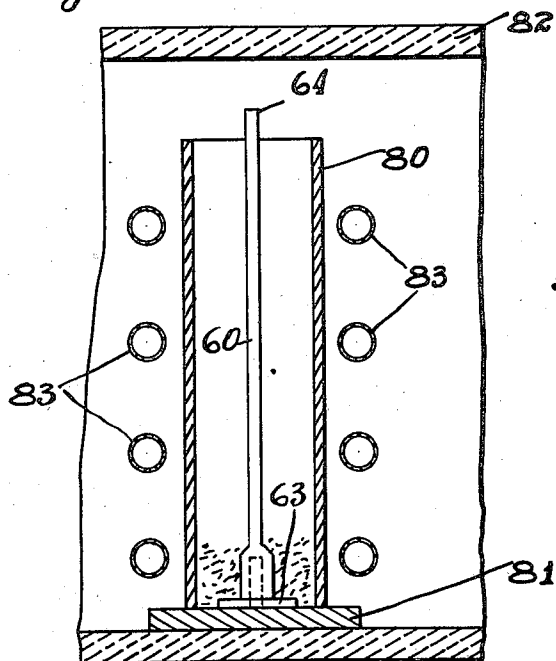
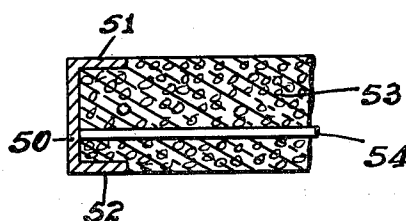


Fig. 7.



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Fig. 8.

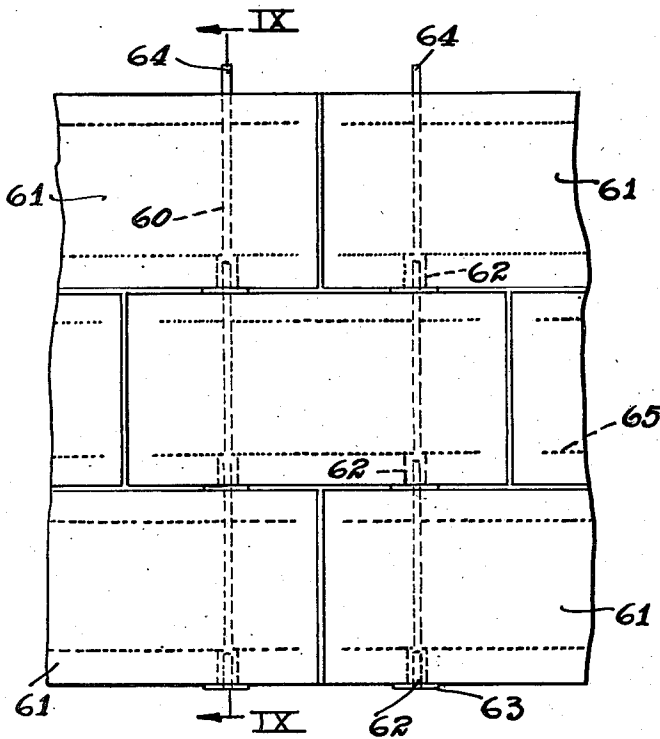


Fig. 9.

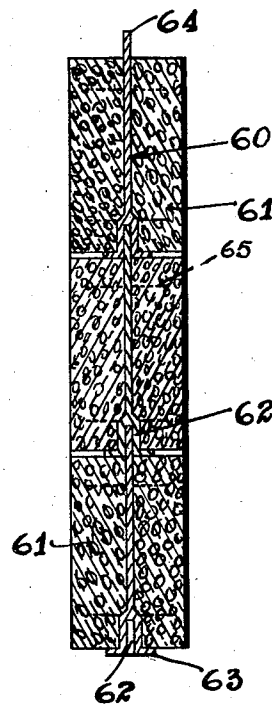
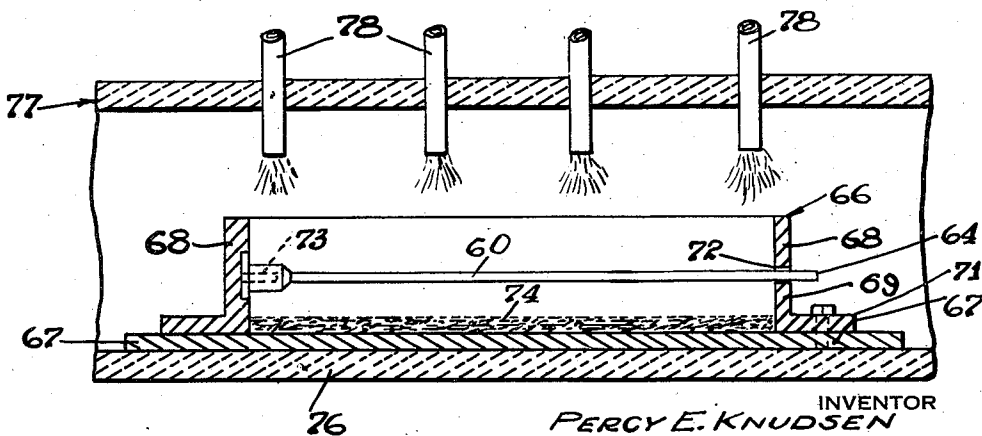


Fig. 10.



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CELLULAR SLAB

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Application March 24, 1939, Serial No. 263,926

3 Claims. (Cl. 72-68)

The present invention relates to structural slabs or blocks of cellular material suitable for use in the fabrication of buildings, and it has particular relation to the fabrication of slabs of cellular glass or glass-like materials.

One object of the invention is to provide a lightweight, thermally non-conductive and chemically-resistant slab capable of withstanding relatively high bending loads without breakage.

A second object of the invention is to provide a simple and convenient method of fabricating slabs of the foregoing type.

In the fabrication of walls, floors and roofs or similar shell portions of buildings, a common material has heretofore comprised concrete, i. e. a stone-like agglomerate of gravel, sand, and Portland cement. Such material is low in tensile strength, is extremely heavy and dense, and therefore slabs, possessing adequate resistance to breakage, under bending loads, must be comparatively heavy and massive. Accordingly, the use of the slabs in buildings imposes heavy loads upon the supporting elements thereof. Furthermore, the heavy, dense bodies are relatively conductive to heat and unless special means is provided for the insulation of the building fabricated from them, heat losses through the slabs is likely to be excessive.

In accordance with the provisions of the present invention portions of the shells of buildings such as walls, roofs and floors are formed of reinforced slabs of highly cellulated glass, or a cellulated blast furnace slag having low specific gravity and great thermal insulating value, thus simultaneously enormously decreasing the loading of the supporting elements in the building and reducing heat transmission through the building shell.

For a better understanding of the invention reference may now be had to the accompanying drawings in which

Fig. 1 is a fragmentary cross-sectional view of a building deck or wall constructed in accordance with the provisions of the present invention.

Fig. 2 is a fragmentary sectional view substantially upon the line II-II of Fig. 1.

Fig. 3 illustrates a slightly modified form of means for mounting slabs.

Fig. 4 illustrates a method of forming the slabs constituting the subject matter of the invention.

Fig. 5 is a sectional view of a roofing or flooring structure embodying blocks or slabs constituting the subject matter of the present inven-

tion and having protective coatings thereupon.

Fig. 6 is a sectional view illustrating a convenient method of forming the slab illustrated in Fig. 3.

5 Fig. 7 is a sectional view of a further modification of the slab shown in Figs. 1 and 2.

Fig. 8 is a fragmentary elevational view of a wall embodying blocks having a modified form of reinforcement.

10 Fig. 9 is a sectional view substantially upon the line IX-IX of Fig. 8.

Figs. 10 and 11 are sectional views illustrating two methods of forming the slabs shown in Figs. 8 and 9.

15 In the drawings like numerals refer to like parts throughout.

A deck, such as a roof or floor constructed in accordance with the provisions of the present invention as illustrated in Figs. 1 and 2 may comprise a series of panels or slabs 10 (preferably of square or rectangular outline) disposed in rows between structural beams, such as rafters or joists. The latter elements, in the form shown, comprise bars of iron or other metal, or wood, which at their ends are supported by any suitable means (not shown). They may be of inverted T cross-section and may include a vertical web 12 and transverse flanges 13, that support the slabs.

20 The slabs 10 comprise an appropriate frame 14 consisting of angle bars 14, which are welded or otherwise secured together at their extremities. One flange 16 is vertically disposed partially or completely to cover the edge of the slab and the other flange 17 is inwardly directed to provide a bearing surface for the edge of the slab. Transversely-extending reinforcing rods 18, plain or deformed, interconnect two opposed sides of the frame and are affixed thereto by welding or by other convenient means in order to provide a grill, which, preferably as shown in Fig. 2, is disposed near the bottom of the slab. These rods are of substantial size—usually one-eighth inch in diameter, or greater. The space within the frame and about the rods is filled with cellular glass, i. e. a highly cellulated glass having a density of less than 1 and having high resistance to conduction of heat. The preparation of the glass body will be described later.

25 The frame of the slab may be connected or affixed to the supporting members 11 in any suitable manner. In the form of the invention illustrated in Figs. 1 and 2, holes are formed in the webs 12 and pins 19 are inserted through the

openings and embedded in the cellular material within the frame.

A slightly modified means for securing the slabs to the rafters or beams is illustrated in Fig. 3. In this construction holes are formed in the webs 21 of supporting beams 22, corresponding to beams 11 and bolts 23 are threaded into mat-
 5 ing openings in the flanges 24 of the frames 26, of the panels 27. The space between the adjacent panels may be filled with sealing material such as mastic or a cement, indicated at 28.

A convenient method of forming the cellular glass body is illustrated in Fig. 4. According to this method, the frame 14 is disposed with flange 17 upon a slab 31 of refractory material, such as a high chromium steel, carborundum, ceramic material, or any other material having high mechanical strength, and being capable of with-
 10 standing high temperatures. In order to prevent adhesion of cellular glass to the slab, the latter may conveniently be powdered with or washed with a slip, comprising highly refractory substance, such as lime, magnesia, graphite, carbon black, or the like. The frame is then partially filled with an appropriate amount of a mixture of glass properly crushed, for example, to a particle size, such that most of it will pass a screen of approximately 75-100 mesh. The thickness of this layer may be about one-seventh that of the finished slab. This crushed glass is admixed with a suitable amount of a gassing agent, such as finely-divided calcium carbonate (preferably chemically precipitated calcium carbonate) of a grade similar to whiting. The amount of calcium carbonate is susceptible of variation, but usually is within the limits of 1 to 2 per cent, e. g. about 1½ per cent.

The mixture of crushed glass and calcium carbonate is leveled off and the slab with the frame disposed thereupon is slid into a conventional furnace 33, having a bottom 34 and a roof 35. Any convenient means may be employed to heat the mixture within the frame, but conventional gas burners 36 constitute an example of such means. Within the furnace the mixture of crushed glass and gassing agent is heated to a temperature sufficient preliminarily to sinter the particles of glass together at their points of contact, but not to melt it down to a fluid mass. This usually occurs at a temperature of about 1200 or 1400° F. Heating is then continued to and somewhat above the temperature of decomposition of the gassing agent (calcium carbonate). Such decomposition usually occurs at a temperature of about 1400 or 1500° F. The temperature is then further raised to about 1600 or 1800° F., but should not become so great as to effect complete fusion and blending of the particles of glass. As the gassing agent decomposes liberated carbon dioxide bubbles are formed in the mass and these expand to provide a thoroughly cellulated mass of desired thickness. When the expansion is complete, heating is discontinued and the bodies are gradually cooled to effect annealing.

The cellular mass thus obtained is extremely light in weight. In many cases the specific gravity may be as low as 0.3 or 0.4 and is highly resistant to conduction of heat. Although it inherently is relatively weak in tension and therefore is but poorly adapted to withstand bending stresses, the rods 18 embedded therein greatly increase the strength of the slab in tension. The joining of the rods to the sides of the frame assure that the tensional forces exerted upon the

rod are transmitted to the sides of the frame and even though adhesion between the rods and the glass is slight great strength of the slab is assured.

It will be apparent that the slabs, by reason of their highly cellular structure, are somewhat poor in resistance to crushing forces, particularly if the latter are concentrated. Therefore, if these slabs are to be used as floors or even as roofs, it is sometimes desirable to provide more resistant surfaces. This may be accomplished by coating the slabs with a layer 37 of concrete, asphalt, or the like illustrated in Fig. 5. In this form of the invention it will be observed that the slabs are supported upon the same beams 11 of T cross-section in connection with Figs. 1 and 2, already described, and are locked in position by pins 19 in holes, in webs 12. In order to permit the insertion of pins 19 a portion 38, of the cellular glass adjacent to the opening may be chipped from the slab as indicated at 39. The notch thus formed is filled by the material forming the layer 37.

It is also possible to provide the cellular slab with a relatively dense hard surface layer 41 illustrated in Fig. 3. In order to form such layer frame 42 of angle irons may be inverted upon a slab 43, as illustrated in Fig. 6. A thin layer 44 of crushed glass containing not more than about ½ per cent of calcium carbonate is then superposed upon the slab and subsequently additional crushed glass containing the proper amount of calcium carbonate for maximum cellulation is distributed over the crushed layer. When the slab is heated by burners 46 in the furnace 47 to the temperature requisite for its formation, the upper layers of crushed glass are sintered together and then strongly cellulated. However, but comparatively slight cellulation occurs in the layer adjacent the supporting slab 43. When the slab is removed from the furnace and annealed it is found to possess a strong rigid surface capable of bearing concentrated loads of considerable magnitude. However, the main body of the slab is adequately cellulated in order to obtain low weight of the body as a whole and to obtain adequate thermal insulation.

Fig. 7 illustrates a slightly modified form of frame for the slab in which the angle irons disclosed in Fig. 1 are replaced by channel irons 50, the flanges 51 and 52 of which overlap the edges of the cellulated glass 53 upon both sides. This construction is somewhat stronger than a simple angle iron construction. Furthermore, all corners of the cellulated glass are enclosed and protected by the frame. Reinforcement rods 54 interconnect two opposed sides of the slabs.

In Figs. 8 and 9 is shown a block or slab structure which is particularly suitable for use in the fabrication of vertical walls. In this embodiment of the invention reinforcing rods 60 are embedded at suitable intervals in slabs 61 of cellulated glass formed by heating an appropriate mixture of crushed glass and calcium carbonate in a mold. The rods at one end, are provided with socket portions 62, having flanges or heads 63, which provide bearing surface for the rods upon the surface of the glass. It will also be observed that the rods include projecting portions 64, which, when the blocks are laid, one upon top of the other, are adapted to project into the sockets of the rods in the adjacent course, thus positively tying the blocks together into a unitary construction. The joints between

blocks may be sealed with cement or mastic. If desired, rods of alternate blocks may be replaced, with tubes having an internal diameter sufficient to admit the projecting ends 64 of the rods of the adjacent blocks. The sockets on the rods may then be eliminated. Reinforcing wires are indicated at 65.

Two methods of forming the type of blocks illustrated in Figs. 8 and 9 are shown in Figs. 10 and 11. In the method shown in Fig. 10, a mold 66, comprising a bottom slab 67 and side walls 68, is formed of refractory material. At least one wall, e. g. 69 is movable with respect to slab 67 and may comprise a flange 71 secured to the base by bolts. The movable wall is formed with openings 72 through which the adjacent extremities 64 of rods 60 loosely project. The socket portions 62 of the rod may be supported by pins 73 projecting inwardly from the opposite wall 68.

In the operation of the method, the sides 68 and 69 may be superposed upon slab 67 and the inner surfaces coated with a powder or slurry of lime, or other wash, to prevent adhesion of the block. The reinforcing rods are then placed in position and a layer 74, of powdered glass, or blast furnace slag, admixed with a gassing agent, is spread to desired thickness upon the slab. The mold is subsequently slid upon the bottom 76 of furnace 77 and heated by burners 78 to form a coherent cellulated body, which is subsequently annealed. In order to remove the blocks from the mold, side 69 is first removed from portions 64 and the slabs are slid forwardly until sockets 62 clear pins 73, after which the block may be lifted bodily from the mold.

In the method illustrated in Fig. 11 a tubular mold 80, of appropriate cross-section and of a height corresponding to blocks 61, is superposed upon a slab 81 and the inner surfaces of the assembly are suitably washed with lime or other material to render the surfaces non-adhesive. Rods 60 are properly placed in the molds with flanges 63 resting upon the slab. The mold is then filled to an appropriate depth (e. g. one-seventh its height), with crushed glass admixed with a gassing agent and the assembly is inserted in furnace 82. Flames from burners 83 play upon the mold until the contents are sintered, and a coherent cellular block is formed. When the block has been removed from the furnace, annealed and cooled the mold may be forced or lifted off therefrom. Fluid cellular

material may, also, be poured into the molds directly and hardened by cooling.

An important feature of the invention as herein disclosed consists in the fact that because of its peculiar nature, it is possible to embed rods of substantial size, e. g. of a diameter of one-eighth or one-half inch, or even larger with cracking the glass. This, of course, would be impossible with ordinary glass.

The forms of the invention herein shown are to be considered merely as illustrative. It will be apparent that numerous modifications may be made therein without departure from the spirit of the invention or the scope of the appended claims.

What I claim is:

1. A method of fabricating reinforced slabs of cellular glass which comprises disposing a frame of a contour corresponding to that of the desired cellular glass slab and having reinforcing rods interconnecting two opposed sides thereof, upon a slab providing a temporary mold bottom, partially filling the frame with a mixture of crushed glass and a gassing agent, heating the mixture to a temperature above that of sintering of the particles of glass and decomposition of the gassing agent, in order to form an expanded but coherent cellular body filling the frame and having the rods embedded therein, and further having a permanent frame disposed thereabout, then annealing the slab.

2. A block of cellular glass having reinforcing rods embedded therein, the rods at one end projecting beyond the edge of the block and having sockets at the other end to receive the projecting portions of the rods in the adjacent block, when the blocks are laid in the wall, the socket ends of said rods having flanges providing bearing surfaces upon the glass.

3. A composite slab-like building unit adapted to be laid in a reclining position and being capable of withstanding relatively high bending loads without breakage, comprising a layer of highly cellulated glass having low heat conductivity and low resistance to crushing forces, metallic reinforcements embedded in the cellular layer near to the bottom of the slab, the reinforcements being attached to members disposed transversely thereof and providing a bearing upon the cellular material, the upper face of the layer of highly cellulated glass being bonded to a facing layer of relatively dense material having high resistance to crushing forces.

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