Aug. 7, 1928. 1,679,599

P. H. BEVIER

BUILDING CONSTRUCTION

Filed Nov. 9, 1925

Fig. 1.

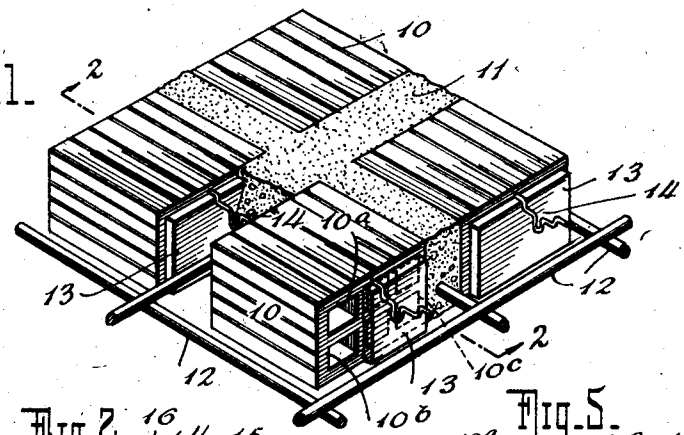


Fig. 2.

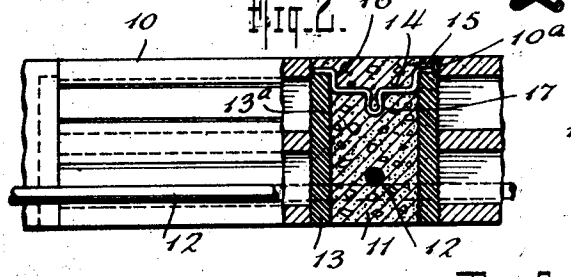


Fig. 5.

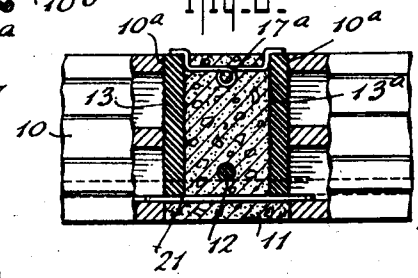


Fig. 3.

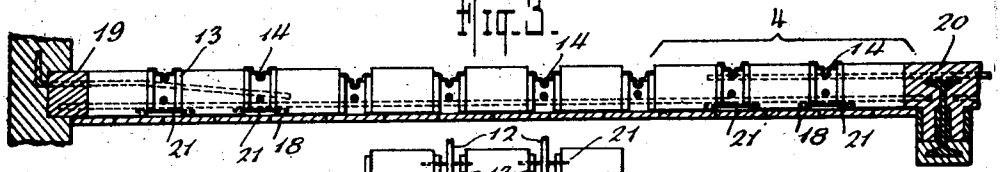


Fig. 4.

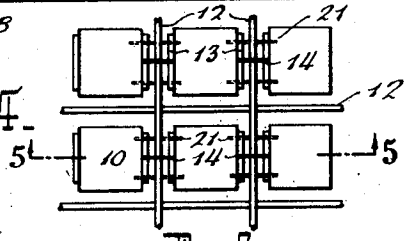


Fig. 6.

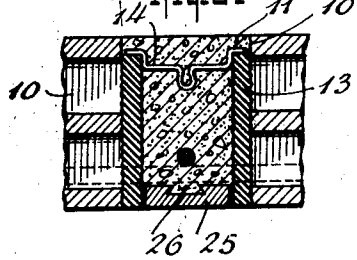


Fig. 7.

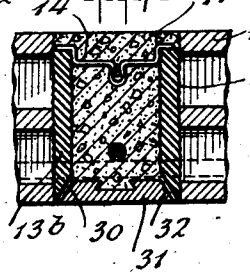
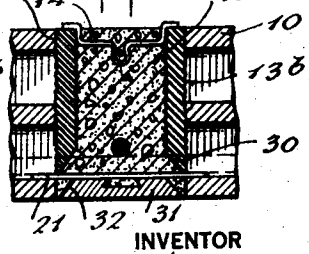


Fig. 8.



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UNITED STATES PATENT OFFICE.

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BUILDING CONSTRUCTION.

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This invention relates to building constructions and particularly to "two-way" reinforced hollow tile and concrete floor constructions.

In order to reduce the dead weight of floor constructions in fireproof buildings, it is customary to employ hollow tile placed at regularly spaced intervals between masses of concrete which form, in effect, joists or beams, and in which are imbedded steel rods. The concrete joists with the steel rods imbedded therein extend in two directions across the floor at right angles, this being known as a two-way reinforced floor.

In a floor of one simple span, the compression in the floor structure or beam, due to the weight of the structure itself, and the superimposed load which it carries, is greatest at the upper surface of the floor and diminishes uniformly toward approximately the center at a line or plane known as the neutral axis.

At the neutral axis there is neither horizontal compression nor tension. Below the neutral axis the tension stresses increase toward the lower side where the steel reinforcement is located to resist them.

In a floor with continuous spans, where the steel members are carried over the supporting girders, the compression stresses occur as before in the upper portion but over about one-half of the entire central portion of the span, while for a distance of approximately one-fourth of the span from each support or girder, the compression is greatest at the bottom and diminishes upward to the neutral axis, above which the stresses are tensional, and consequently in these portions of the floor the steel is placed near the top to resist the negative bending moment over the supports.

From this it will be seen that any floor construction to be entirely safe and economically designed must make provision for this reversal of stresses.

According to the principles of my invention, in both of the above cases, the compressive forces are resisted by the combined concrete and tile and equal ultimate strength can be secured either at the top or bottom of the floor structure.

The principal object of this invention is to provide a new and improved construction of a two-way hollow tile and reinforced concrete floor, particularly adapted to give the greatest strength in all portions of the floor. Considered more specifically, the object of the invention is to provide in a floor construction of the type referred to, a plurality of slabs placed at the open ends of the hollow tiles in such a manner as to insure the presence of a solid mass of concrete between the adjacent ends of the tiles and in direct contact with them either at top or bottom so as to resist the compressive forces according to the strains upon the floor structure at each particular region thereof.

Another object of the invention is to provide a new and improved device for holding the slabs properly in position, while the concrete is being placed between the tiles to form the concrete joists of the floor structure. These and other objects of the invention will appear more fully from the following more detailed description and by reference to the accompanying drawings forming a part hereof and wherein Fig. 1 is a perspective view of a portion of a floor construction embodying my invention; Fig. 2 is a section on the lines 2—2 of Fig. 1; Fig. 3 is a section upon a reduced scale through a portion of a typical continuous span floor construction; Fig. 4 is a plan view of a portion of the span shown in Fig. 3; Fig. 5 is a section on the line 5—5 of Fig. 4; Fig. 6 is a section similar to Fig. 2 showing an application of my invention to an all tile ceiling floor construction; Figs. 7 and 8 are sectional views of a slightly modified all tile ceiling floor construction corresponding respectively to the showings of Figs. 2 and 5.

As shown in Fig. 1 of the drawing, the floor is constructed of the open ended hollow tile 10 arranged at spaced intervals. In the spaces formed between the tiles the concrete 11 is poured or tamped, thus forming, in effect, a plurality of concrete joists extending at right angles to and intersecting each other. Imbedded in each of the concrete joists is a steel reinforcing rod 12, the rods extending in one direction being placed above and preferably resting upon the rods which extend in the other direction, as clearly shown in Fig. 1 of the drawing. In order to prevent the concrete from entering the open ends of the hollow tiles 10, I provide slabs 13 preferably constructed of concrete or fire clay, although said slabs may be constructed of any suitable material having sufficient strength and rigidity. The height of each slab preferably is less than the height of the hollow tiles by an amount about equal

to the thickness of the tile shell, while the length of each slab is less than the width of the tile by an amount about equal to the thickness of two tile shells. When the dimensions of the slab relatively to the tile are, as stated above, it will be seen that if a slab is placed on its edge with its flat face in contact with the open end of the tile, as shown in Fig. 1 of the drawing, the slab will entirely close the open end of the tile, the upper edge of the slab extending to the lower surface of the upper shell 10^a of the tile, and the end edges of the slab extending to the inner surfaces of the side shells 10^b and 10^c of the tile or slightly overlapping same. As clearly shown in Fig. 2 of the drawing, I place a slab 13 at the end of each tile, so as to close the open ends thereof, and in order to hold the slabs in position, during the time the operation of forming the concrete joists is carried on, I employ a spreader 14 constructed of a relatively thin wire, having sufficient resiliency to hold the slabs firmly pressed against the ends of the tiles.

Each of the spreaders 14 is provided adjacent to its ends with a double right angled bend which forms a short horizontal portion 15, and a short vertically extending portion 16; the horizontal portion 15 being placed upon the upper edge of a slab 13 and the vertical portion engaging the side face of the slab.

In order to increase the resilient properties of the spreaders and also to permit them to be adjusted readily to different lengths, I form the central portion with a loop 17 which may be in the form of a re-entrant bend as shown in Fig. 2, or which may be in the form of the circular loop 17^a, as shown in Fig. 5. The loop 17 or 17^a in addition serves to bring the center of gravity of the spreader well below the horizontal end portion 15 of the spreaders so that when the spreaders are placed in position upon the slabs they will always hang in their intended position in a condition of stable equilibrium. The use of resilient spreaders instead of rigid members for holding the slabs in position during the operation of forming the concrete joists not only insures that the slabs will be more securely held in position, but also permits the spreaders to yield under compression, thereby insuring that the compression stresses will be resisted by the concrete of the joists and not to any appreciable extent by the spreaders.

The method of constructing a floor in accordance with the principles of my invention is as follows: The tiles 10 are placed in the desired spaced relationship upon the temporary centering or supporting boards 18, and the reinforcing rods 12 are laid across in the spaces between the tiles, after which the slabs are stood upon their edges so as to extend vertically in contact with the open ends of the tiles, a spreader 14 being placed over the top edges of the slabs to hold them tightly pressed against the open ends of the tiles. As shown in Fig. 3 the slabs 13 in the central half of the span between the girders 19 and 20 are placed directly upon the temporary centering 18, so that their lower edges lie in the same plane as the lower outer faces of the tiles, while in each quarter of the span adjacent to the girders 19 and 20, the slabs are placed so that their upper edges lie in the same plane as the upper outer faces of the tiles.

The construction preferred for a simple span or the central portion of a continuous span is shown more clearly in Figs. 1 and 2 of the drawing, from which it will be noted that the upper edges of the slabs terminate substantially in the same plane as the inner face of the upper shell 10^a, thus leaving the end walls of the upper shell 10^a uncovered by the slab. As heretofore pointed out, the length of the slab is less than the width of the tile by an amount equal to approximately double the thickness of the tile shell, and the slabs are placed centrally of the tiles so as to leave the ends of the side walls 10^b, 10^c, uncovered.

In order to hold the slabs properly in the upper position they are intended to occupy in a continuous span construction, as shown in Fig. 3, in the quarter spans adjacent to the girders 19 and 20, I provide a plurality of short lengths of relatively thin wire which form carriers 21. The length of these carriers is slightly greater than the spaces between the tiles, and said carriers are placed with their ends projecting into the cells of the tile so that they are supported by the inner face of the lower shell of the tile. Two carriers are preferably placed across the space between two adjacent tiles, so as to bridge this space, and the lower edges of the slabs are placed upon the carriers, thus bringing the upper edges of the slab in substantially the same plane as the upper face of the tiles, as shown in Fig. 5 of the drawing. With the slab held in this position, it will be seen that the end faces of the lower shell of the tile will be uncovered. After all of the tiles are placed in position, the concrete is then placed in the spaces between the tiles to form the concrete joists 11. As the metal carriers 21 are constructed of relatively thin material the space or opening between the lower edge of the slabs, when they are supported in the manner shown in Fig. 5, is not large enough to permit any of the concrete to flow into the cells of the tiles, the opening being but slightly larger than the grains of the concrete mixture. The entry of the concrete into the ends of the cells, when the carriers 21 are employed, is furthermore most unlikely, because the lower edge of the slab projects outwardly beyond

the line of possible entry of the concrete into the tile cells, so that when the concrete is poured it could not flow directly towards the opening, but would have to be pushed upwardly from below the lower end of the slab to enable it to flow or be forced into the tile cell.

Analyzing a floor construction as disclosed above, it will be noted that in the central portion of a span where the compression stresses are located above the neutral axis and greatest at the top of the floor, the concrete which forms the joist 11 extends to and is in contact with the end faces of the tiles at the top and sides thereof, while in the portions of the span, adjacent to the girders 19 and 20, the concrete of the joists 11 extends between and is in contact with the end faces of the tiles below the neutral axis at the sides and the bottom of the tiles.

The sides of the slabs are preferably grooved or scored as indicated by the reference character 13ª, so that the concrete will adhere strongly to the slabs to form therewith an integral unitary structure, whereby the concrete and tiles will act together in resisting compression and shear. With the structure shown, it will be noted that in the first case, i. e., slabs in the lower position, the concrete of the joists 11 contacts with the end of the tile shell along the entire top shell 10ª and the entire side shells 10ᵇ, 10ᶜ, while in the latter case, i. e., slabs in the upper position, the concrete of the joists contacts with the entire area of the end of the bottom shell and the ends of the side shells 10ᵇ, and 10ᶜ. In addition, in both cases the concrete contacts with the entire area of the side faces of the slabs. Compression strains in the direction extending longitudinally of the tiles are therefore resisted by the full width of the concrete joists, the two vertical shells at the sides of the tile, the top shell of the tile and the slabs which contact with the ends of the two shells and which slabs are backed up by the interior vertical webs of the tile. In the case of compression at right angles to the former, the resistance is offered by the full width of the concrete joist, plus the transverse cross section of the slabs at each side of the joists, plus the horizontal shell of the tile, either the top or bottom shell depending upon whether the compression is above or below the neutral axis respectively.

It will be seen that the structure herein disclosed will offer greater resistance to compression transversely of the tiles than where thin metal sheets are employed for closures for the ends of the tile cells, because in the latter case, the compression strains are resisted only by the concrete joist and the top shell of the tile. Therefore, by the use of my construction I secure the advantage of the compressive strength of the two slabs, which is from 3000 to 5000 lbs. per square inch of surface.

Where no closures are provided for the open ends of the tile and the concrete is permitted to flow into the tile cells, the concrete forms a small right angle triangular prism having its base at the bottom and its apex at the top of each cell opening, provided, however, that the ideal conditions with respect to the consistency of the concrete and its manner of application are adhered to. In many cases, however, because of the character of labor employed, and the lack of careful supervision, ideal conditions are not adhered to and if the concrete mix is too thin, large quantities of the concrete may flow into the cells until the cells are almost entirely filled. This increases to a dangerous extent the dead load carried by the frame and foundations of the building. Even when the ideal conditions are maintained, the triangular concrete plugs, formed in the ends of the tile cells, are of very little value for resisting compression strains located above the neutral axis and extending at right angles to the length of the tile, because the apex only of the triangular plug is located in the region where the compression is greatest.

In Fig. 6 of the drawing I have shown my invention as applied to a floor construction in which an all-tile ceiling is desired. As shown in this figure, a ceiling tile 25 is placed between the two adjacent slabs 13 at the lower end thereof. The tile 25 is preferably provided with a dove tail groove 26, into which the concrete flows to lock the tile and concrete securely together and hold the tile in position.

In Figs. 8 and 9, I have shown an all-tile ceiling construction in which the principles for continuous span constructions hereinbefore described are employed and by means of which the concrete is most advantageously placed with relation to the tiles for resisting compression at the top or bottom of the floor construction. As shown in said figures the lower edges of the slabs 13ª are beveled or chamfered as indicated by the numeral 30. In Fig. 8 the slabs 13ª are so placed that the upper shell of the tile is uncovered by the slab, while in Fig. 9, the slabs are supported by the carriers 21 so as to bring the upper edges of the slab in the same plane as the upper surface of the tiles. The ceiling tile 31 has its edges chamfered as at 32 to permit the tile to be placed in the lower position shown in Fig. 8. When the tiles are placed in the upper position as shown in Fig. 9, an opening is left between the chamfered faces 30 and 32 which permits the concrete to flow into contact with the ends of the lower shell of the tile.

It will be understood that the constructional examples herein disclosed are merely illustrative, and that many changes, variations and modifications may be resorted to without departing from the spirit of my invention.

As has heretofore been pointed out, my invention is not limited to the use of slabs made of concrete or fire clay, but that plates made of metal, card board, fiber board, or other suitable material may be employed therefore, I wish it to be understood that the term "slab" as used in the claims hereinafter appended is intended to refer to relatively thin plates of the type above described as well as to thicker slabs of concrete, fire clay or the like.

I claim:

1. A reinforced concrete floor construction comprising a plurality of hollow tiles arranged in spaced relationship, and reinforced concrete joists extending across said floor between said tiles, rigid slabs contacting with the open ends of said tiles, the area of a flat face of each of said slabs, relatively to the cross sectional area of each of said tiles, being such that each of said slabs will cover and act as a closure for the entire open part of the end of the tile to prevent ingress of concrete into the tile cells while leaving exposed a portion of the side and top walls or shell of the tile, against which the concrete of the joists abuts, and resilient means to force and hold said slabs with a resilient pressure against the tile ends.

2. A reinforced concrete floor construction comprising a plurality of hollow tiles arranged in spaced relationship, and reinforced concrete joists extending across said floor between said tiles, masonry slabs contacting with the open ends of said tiles, and resilient means engaging the outer faces of said slabs to hold said slabs in contact with the tile ends.

3. A reinforced concrete floor construction as set forth in claim 2 in which said means comprise spreaders, each of which is constructed of a length of spring metal having the ends thereof bent to provide substantially horizontal portions, the length of each of which is approximately equal to the thickness of a slab and a substantially vertical portion to engage the side face of the slabs, said horizontal portions resting upon the tops of a pair of slabs and supporting the spreaders, and said vertical portions holding the slabs in contacting engagement with the ends of the tiles.

4. A reinforced concrete floor construction as set forth in claim 2 in which said means comprise spreaders, each of which is constructed of a length of spring metal having the ends thereof bent to provide substantially horizontal portions, the length of each of which is approximately equal to the thickness of a slab and a substantially vertical portion to engage the side face of the slab, and the central portion of said spreaders being provided with a downwardly extending loop, said horizontal portions resting upon the tops of a pair of slabs and supporting the spreaders, said vertical portions holding the slabs in contacting engagement with the ends of the tiles, and said downwardly extending loop forming a spring like structure for causing said vertical portions to exert a pressure against said slabs.

5. A reinforced concrete floor construction as set forth in claim 1, in which in certain regions of said floor where the compression is above the neutral axis, said slabs are so placed relatively to said tiles as to expose the ends of the upper shells of the tiles, while in other regions of said floor, where the compression is below the neutral axis, said slabs are placed relatively to said tiles to expose the ends of the lower shells of the tiles.

6. In a reinforced concrete floor, the combination with a plurality of hollow tiles arranged in spaced relationship with reinforced concrete joists extending across said floor between said tiles, of a plurality of slabs for closing the open ends of said tiles to prevent ingress of concrete to the cells of said tiles, the width and length of said slabs being less respectively than the height and width of said tiles, and carriers upon which said slabs are supported, said carriers being supported by said tiles and extending across the space between the open ends of adjacent tiles.

7. In a reinforced concrete floor, the combination with a plurality of hollow tiles arranged in spaced relationship with reinforced concrete joists extending across said floor between said tiles, of a plurality of slabs for closing the open ends of said tiles to prevent ingress of concrete to the cells of said tiles, the width and length of said slabs being less, respectively, than the height and width of said tiles, carriers upon which said slabs are supported to hold said slabs with their upper ends in the plane of the upper surface of said tiles, said carriers being provided in those regions of the floor where the compression stresses are located above the neutral plane and being omitted in those regions where the compression stresses are below the neutral plane, in which latter regions the lower ends of the slabs are located in the plane of the lower surface of the tiles.

8. A reinforced concrete floor as set forth in claim 6 in which means are provided to hold said slabs securely against the ends of said tiles.

9. A reinforced concrete floor as set forth in claim 6 in which said carriers are constructed of thin material.

10. A reinforced concrete floor as set forth

in claim 6 in which resilient spreaders are provided to hold said slabs securely against the ends of said tiles.

11. A reinforced concrete floor construction as set forth in claim 1 in which, in different regions of said floor, the slabs are located relatively to the tiles, according to whether the compression stresses are located above or below the neutral axis, so as to expose a portion of the tiles adjacent to the tops or bottoms thereof respectively.

In testimony whereof I have hereunto set my hand.

PHILIP H. BEVIER.