April 7, 1931. E. A. TUCKER 1,799,400

BUILDING CONSTRUCTION

Filed March 19, 1928 2 Sheets-Sheet 1

Fig. 1.

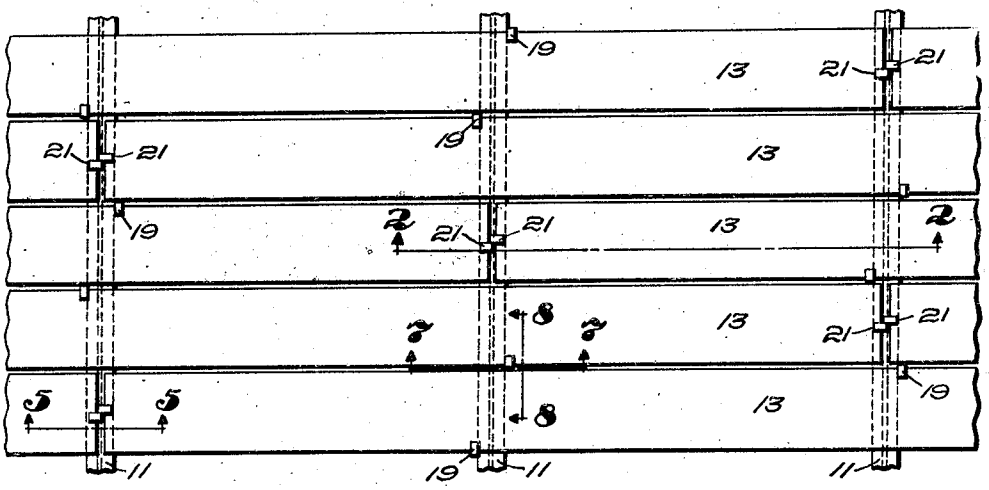


Fig. 2.

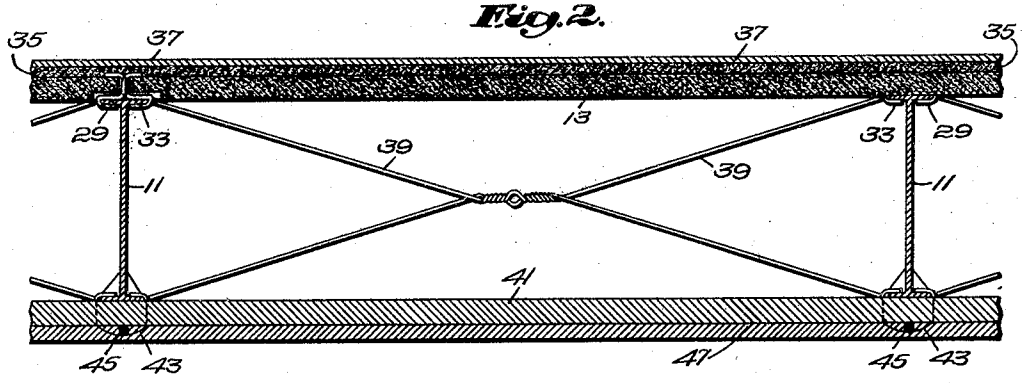


Fig. 3.

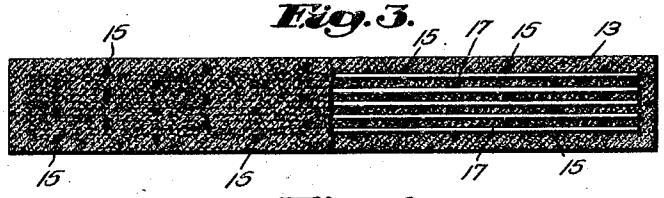


Fig. 4.

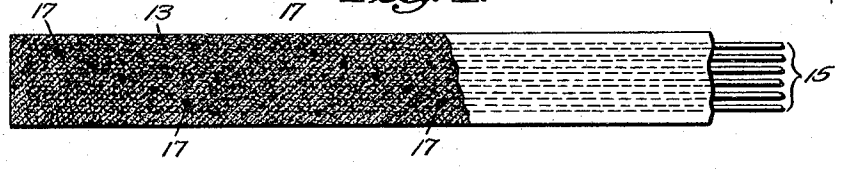


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Fig. 5.

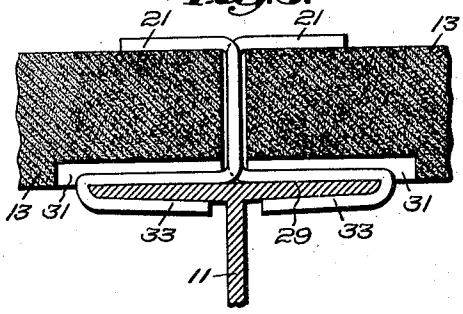



Fig. 6.

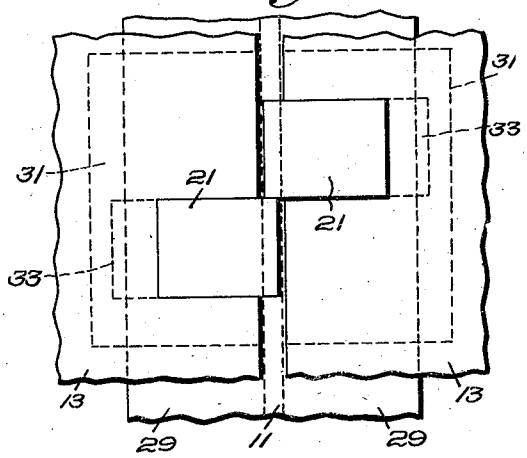



Fig. 7.

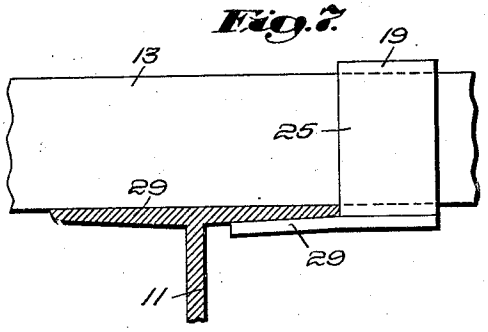



Fig. 8.

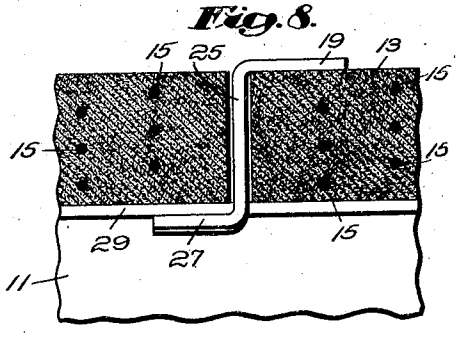
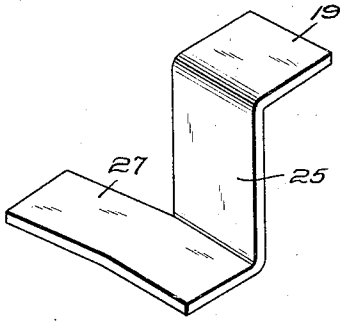



Fig. 9.

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Patented Apr. 7, 1931 1,799,400

# UNITED STATES PATENT OFFICE

EDWARD A. TUCKER, OF WINCHESTER, MASSACHUSETTS

## BUILDING CONSTRUCTION

Application filed March 19, 1928. Serial No. 262,724.

This invention relates to building construction and more particularly to concrete floor or roof construction for buildings where moderate loads prevail, and where a fireproof or fire resisting structure is desired, involving the necessary use of steel floor members, and is designed to provide a construction inexpensive to install, economical in the amount of steel and concrete required, and characterized by a marked reduction for any given load to be carried in the dead weight of materials involved, as compared with prior constructions of this class. While the invention may have application to other uses, for purposes of illustration its application to floor construction is herein described.

Concrete floor construction employing steel floor members as heretofore practised has comprised principally two general types:— In one, the concrete comprising the floor slab has been poured in place about suitable steel reinforcement, which is placed in forms of some kind erected around and between the main supporting members, the latter consisting of steel beams, fabricated sections, or trusses supported upon columns, girders or masonry walls. This type of floor construction is costly, in that it requires the employment of a large plant, skilled and expensive labor, and costly forms which are no part of the permanent structure and are waste material when lumber is employed.

To provide a system where temporary forms and the expense incidental thereto may be dispensed with, and having particular application to structures carrying moderate loads, a second type of floor construction has been utilized employing relatively light steel floor members, usualy light-rolled steel sections or sections made of pressed steel, or light steel trusses spaced closely together to approximate the spacing of wood joists. Stiffened metal lath material is then laid over the tops of the steel floor members spanning the intervening bays, the concrete forming the floor being poured in place over the lath material and the latter serving both as a form and a partially reinforcing element in the completed slab. The operation of installing a floor by this system is economical to the extent that the expense of form work is avoided, a lesser amount of skilled labor is required and a certain amount of concrete is saved. To provide proper bridging support, however, for the metal lath and the concrete poured thereon the spacing of the steel beams is limited to relatively narrow spans, and, because of these limitations in the spacing of the steel beams, the total amount of steel required is so great as to become in many instances a serious economical drawback.

In the type of construction herein described, the floor or that part of it which is relied upon to carry the load is formed by a large number of pre-cast reinforced concrete members each relatively long as compared with its width and thickness, these being brought to the job from their place of manufacture and laid upon the tops of the light steel beams and secured each individually thereto. This construction provides an economical method of installation not only by avoiding the use of forms but also the expense incidental to pouring into place the concrete forming the load supporting portion of the floor slab.

The pre-cast members furthermore are so constructed, and in their assemblage so related to each other and to the steel floor beams, that the spacing of the latter may be greatly increased, resulting as compared with the second method above described in a substantial saving per unit of floor area both of steel and of concrete in the floor slab, a more rigidly braced floor support, and a composite floor of greater resilience than is possible with a poured-in-place slab.

The invention will be best understood by reference to the following description when taken in connection with the accompanying illustration of one specific embodiment thereof, while its scope will be more particularly pointed out in the appended claims.

In the drawings:—

Figure 1 is a plan view showing a flooring area constructed according to my invention with the pre-cast members laid upon and fastened to the floor supporting beams, the fin-

ished floor and cement base therefor not being shown;

Fig. 2 is a section in elevation on an enlarged scale taken on the line 2—2 in Fig. 1 transverse to the floor beams and showing both the finished flooring and ceiling;

Fig. 3 is an end elevation in partial section showing one form of a reinforced, plank-like, pre-cast, concrete member which may be employed in connection with the described floor construction;

Fig. 4 is an end elevation in partial section of the member shown in Fig. 3;

Fig. 5 is a sectional detail on an enlarged scale taken on the line 5—5 in Fig. 1 showing the method of securing the ends of each pre-cast member to the underlying beam;

Fig. 6 is a plan view of the parts shown in Fig. 5;

Fig. 7 is a section on an enlarged scale taken on the line 7—7 in Fig. 1 showing the side clips or anchors for fastening the sides of the pre-cast floor members to the floor beams;

Fig. 8 is a similar sectional detail taken on the line 8—8 in Fig. 1; and

Fig. 9 is a perspective view of the side clip illustrated in Figs. 7 and 8.

Referring to the drawings and to the illustrative embodiment of the invention therein disclosed there are shown in Figs. 1 and 2 a portion of a floor construction in which there are employed the spaced floor supporting beams 11 in parallel arrangement similar to that of wooden joists but spaced apart by a substantial distance. Herein these beams are each in the form of a solid web, rolled I-beam of very light weight section, but, in place thereof, floor supporting beams in the form of fabricated sections or trusses of suitable weight and similarly spaced might be employed and such members I have termed generically "floor beams." These floor beams may be supported by columns, girders or masonry walls as desired.

The load supporting portion of the floor is composed of a plurality of relatively long thin and narrow, reinforced, pre-cast members 13 laid across the top flanges of the floor beams, having bearing thereon and secured thereto in accordance with the system hereinafter referred to.

The pre-cast floor members are preferably constructed in proportions resembling those of wooden planks,—long enough to span two or more (herein three) of the bays between the floor beams, thin and narrow enough to be readily handled, and so reinforced longitudinally as to enable them to withstand not only the deflection incidental to the sustentation of the intended floor load but also such as may arise from their dead weight in transportation or handling. Preferably the ratio of length to thickness or least dimensions should be in excess of fifty to one.

Preferably the longitudinal reinforcement is distributed throughout substantially the entire cross-section of these concrete planks so as to provide a member capable of taking elongation in each component layer or plane thereof in a manner resembling that of a homogeneous beam and capable of experiencing an extreme or abnormal deflection without detriment.

In the illustrated embodiment of the invention the concrete planks are constructed and reinforced as described in my prior Patent No. 1,530,630 dated March 24, 1925, the longitudinal reinforcing wires 15 (Figs. 3 and 4) being arranged in a plurality of layers (herein six) symmetrically with relation to the neutral axis of the plank and with intermediate transverse separating wires 17 all proportioned and related according to the principles disclosed in the said patent. This provides a pre-cast concrete plank, thin, compact and light, but capable of carrying deflection without detriment and of standing up under all normal floor loads required in structures of the class indicated.

To serve as a specific example the pre-cast concrete plank shown in the drawings may be twelve feet long, ten inches wide and one and three-eighths inches thick presenting a ratio of length to thickness of approximately one hundred and five to one, and capable of spanning three of the bays between the floor beams 11, which latter may be spaced four feet apart on centers. It will be understood that these dimensional examples are illustrative only.

In constructing the described form of floor the pre-cast concrete planks having been previously formed and transported to the job, are laid side by side across the top flanges of the floor beams, being preferably spaced apart at their sides and ends by a small gap which, for example, may be one-quarter of an inch but is susceptible of wide variation. These gaps or joints are subsequently sealed by filling with cement, grout or mortar bonding the units together and making a tight continuous floor slab. The separation of the planks by the width of the joint permits securing a true alignment of the planks and tends to tie the planks together by an intervening key of cement of substantial amount. The planks are also preferably arranged with their end joints in staggered relation to the floor beams (Fig. 1) so that each beam is overlapped by one or more (herein two) of adjacent planks.

If desired, the sides of each plank may be beveled inwardly and upwardly, instead of being straight as shown in Fig. 8, so that the sides of adjacent planks diverge upwardly at a slight angle serving to make the mat, which forms the finished floor as subsequenty described, more effective in distributing any concentrated loads over adjacent planks because of the wedge-shaped joint.

Each plank is anchored or secured to each underlying floor beam on which it has bearing by suitable fastening means which herein comprise side clips 19, for fastening together the plank and each floor beam overlapped thereby, and end clips 21 for fastening together the end of the plank and the beam on which it rests.

Each side clip (Figs. 7, 8 and 9) consists of a flanged plate 19 adapted to overlie the upper edge of the plank and extending at right angles from the upright portion 25 which passes down at the side of the plank through the gap or joint between the same and the next adjacent plank and carries at its lower end the extension plate 27 which is forced into gripping engagement with the under side of the flange 29 of the floor beam 11.

The ends of the planks are anchored to the floor beam on which they rest by means of the end clips shown in Figs. 5 and 6. Each clip comprises a U-shaped member 21 fitting over the end of the plank, the latter being recessed at 31 on its under side to receive the lower leg of the U, so that a full direct bearing of the plank on the floor beam may be assured. Abutting or opposing edges of the two aligned planks are anchored by adjacent clips arranged at opposite sides of the medial line of the planks. The lower leg of each clip has a reverse bend 33 which is forced into gripping engagement with the under face of the flange of the floor beam so that the end of the plank is rigidly held with relation to the beam.

The holding clips are preferably arranged according to some system such as that illustrated in Fig. 1, so that while each plank is anchored to each floor beam, the end and the side anchors for any one floor beam are distributed along the same at spaced intervals.

The described construction of fastening devices and the arrangement thereof not only holds the concrete planks down to a bearing on the floor beams so that a full bearing is preserved at all times by the planks on the floor beams irrespective of the application of a concentrated load at any single bay, but it also enables the planks themselves to serve as a multiplicity of lateral braces for the floor beams preventing any buckling of the top flange of the steel floor beams thereby adding materially to the rigidity and strength of the composite floor.

This rigid bracing is materially increased by arranging the planks so that each one spans at least two of the bays intermediate the floor beams.

To complete the finished floor, the end and side joints between the planks are filled with cement or the like and a top floor finish is added preferably by applying a shallow cement finish 35 (Fig. 2) of sufficient depth to cover the upper exposed portions of the end clips 21 and side clips 19 and of such additional depth only as may be required for the character of surface finish to be applied. This not only serves to bond together the pre-cast units but to bond to the resulting continuous slab the fastenings between the individual units and the beams. In Fig. 2 there is shown a surface finish 37 which may be of linoleum or other composition laid directly on the cement finish, but, if desired, wooden screeds may be embedded in the surface cement 35 to receive a wooden flooring or a nailing concrete may be used for the finish 35 to which the wooden flooring is directly nailed. Preferably the joints between the concrete planks are filled by the cement, concrete or other material which is applied to form the finish 35 so that the filling acts as a key to unite the top bedding to the floor members as well as a seal and fire stop for the floor members. The pre-cast concrete planks united to the floor beams as described, constitute the main load supporting portion of the floor and the particular construction of floor finish applied to the top thereof is immaterial.

Tie wires 39 (Fig. 2) to serve as bridging for erection use may be employed if desired between the floor beams, such bridging wires being located so that they are located within the joints between the concrete planks.

Any desired type of ceiling, either part or full fireproof, may be employed in connection with the described floor construction. I have herein shown a ceiling construction comprising pre-cast gypsum or reinforced concrete slabs 41 applied to the under side of the floor beams and reinforced, held in place by the fastening wires 43 secured to the lower web of the floor beams holding the supporting rods 45 which underlie the slabs 41. The under side of the ceiling slab 41 has applied thereto the finishing plaster covering 47.

The use of the pre-cast members in lengths sufficient to carry over two or more bays, and arranged so as to break the joints on staggered lines, combined with the clips or anchors to the steel floor beams, causes the floor to act as a unit and, while providing a floor having a greater resilience than is possible with a poured-in-place slab, affords a continuity similar to that secured by a monolithic slab. This feature not only causes the floor to act as a unit, but provides a continuous tie between the walls of the structure and the continuously tied floor itself.

This system of construction, especially for cases involving moderate loads, provides an inexpensive floor construction of light weight, low dead load, with the most economical distribution of steel between the floor beams and the reinforced floor members and a minimum amount of concrete for the load to be carried, and with the floor beams laterally braced to a degree not obtainable by any other type of

floor construction of which I am aware and particularly efficient in its application to structures employing floor beams of the light I-beam type, which, because of their lightness and strength, constitute desirable structural elements in this class of flooring.

In the usual type of floor slab poured in place in temporary forms, in order to reduce the number of panels and the resultant expense of the forms themselves, the beams must be spaced apart by substantial distances and the thickness of the slab, which is usually about one twenty-fifth of the width of the span, and in any event cannot be reduced to anything comparable with the permissible thickness of the described form of concrete plank, becomes so great as to provide a dead load far in excess of anything required in the construction herein described. Furthermore, the standard sections of steel beams are so designed that their full strength cannot be developed under general conditions except by a spacing requiring a slab of at least four inches in thickness and oftener a wider spacing and greater thickness. These constructions, therefore, lead to an increase in dead weight and a design which is a compromise between loss of economy in the steel design and loss of economy in the dead weight.

In the floor construction previously described, where the slab is poured in place on metal lathing or the like, the metal beams must be spaced closely together, resulting in an uneconomical use of the steel, especially where I-beams are employed, and resulting also in a slab which must have a minimum depth yielding a ratio of slab thickness to the span seldom more than one to ten or one to fifteen, thereby producing a large dead load as well as a structurally poor floor ineffectively reinforced.

In the herein described construction, the low weight and thickness of the well-reinforced, pre-cast unit permits the use of steel floor beams of light weight but with their full strength developed, which beams could not be used with the excessive dead weight of a poured-in-slab, such light weight beams being spaced at distances impossible to provide in the case of the poured-in-place slab on the metal lathing. The combination of these factors makes it possible to obtain a floor construction where the space between the beams spanned by the floor slab bears a ratio to the thickness of the pre-cast units of thirty to one or more, yielding the minimum of dead weight with full economy of the supporting beams and no limiting conditions of form costs or depth of slab.

By the method described there is secured a floor (or roof) construction requiring no forms, no plant to install and no especially skilled labor. By suitably disposing the reinforcement in the pre-cast member, concrete planks may be constructed capable of carrying a load which, in a poured-in-place concrete slab, would require a depth of concrete, and consequently yield a dead weight, several times greater. It therefore becomes possible to space the light weight steel beams farther apart than has been previously possible in the metal lath construction reducing the aggregate amount of steel comprised in the floor beams and the floor slab in some instances by 25% or more, and the total weight of concrete in some instances by 50%, thereby reducing the expense, the dead weight carried and providing a more rigid, less expensive and more easily constructed floor.

Each pre-cast floor plank is preferably fully cured or set before being laid and, because the load supporting portion of the floor consists of a multiplicity of such planks, there are eliminated any internal stresses in the floor which frequently develop in the case of a continuous poured-in-place slab, in which such internal stresses, set up through shrinkage, expansion and contraction arising in the process of curing or setting, may be a source of weakness in the slab and the supporting steel frame.

While for purposes of illustration I have herein described one specific type of floor construction with specific dimensional relations, it is to be understood that these details are illustrative only and that the principles underlying my invention may be applied in widely differing form and to purposes other than that herein illustrated in detail.

Claims—

1. A building construction comprising a plurality of spaced steel beams and a load-supporting slab carried thereby the same comprising a plurality of separate pre-cast reinforced concrete plank-like members of relatively great length as compared with the thickness, said members being laid transversely across said beams, each plank spanning a plurality of the intermediate bays and having its ends and one or more intermediate portions bearing on said beams, means for fastening each plank to each beam on which it has bearing means for bonding together said members to form a continuous composite slab.

2. A building construction comprising a plurality of spaced steel beams and a load-supporting slab carried thereby, the same comprising a plurality of separate pre-cast reinforced concrete plank-like members laid transversely across and bearing on said beams, each member spanning a plurality of the intermediate bays and having a ratio of length to thickness not less than fifty to one, means for fastening each individual member to each beam on which it has bearing and means for bonding together the said members to form a continuous composite slab, said slab and beams serving mutually to reinforce each other.

3. A building construction comprising a plurality of spaced steel beams, and a continuous composite slab supported by said beams comprising a plurality of pre-cast reinforced concrete members of relatively great length as compared with thickness each member spanning a plurality of bays intermediate said beams, means for fastening each of said members to underlying beams to cause the slab and beams mutually to reinforce each other.

4. A building construction comprising a plurality of spaced steel beams, a load-supporting slab carried thereby comprising a plurality of pre-cast heavily reinforced concrete plank-like members capable of elongation in each component layer in a manner resembling that characteristic of a homogeneous beam said members being arranged transversely said beams and spanning a plurality of bays intermediate the beams and having bearing thereon and means for securing each of said members to each beam on which it has bearing.

5. A building construction comprising a plurality of spaced steel beams and a slab supported thereby comprising a plurality of separate pre-cast concrete members of relatively great length as compared with thickness laid transversely on the steel beams and fastened each thereto, each member spanning a plurality of bays intermediate the beams and each member being reinforced by a plurality of layers of longitudinal reinforcement distributed throughout its cross-section on opposite sides of its neutral axis.

6. A building construction comprising a plurality of spaced steel beams and a slab supported thereby comprising a plurality of separate pre-cast concrete members having a ratio of length to thickness of not less than fifty to one laid transversely on the steel beams and fastened each thereto, each member spanning a plurality of bays intermediate the beams and each member being reinforced by a plurality of layers of longitudinal reinforcement distributed throughout its cross-section on opposite sides of its neutral axis.

7. A building construction comprising a plurality of spaced steel beams and a continuous composite load-supporting slab carried thereby, the same comprising a plurality of separate, pre-cast, reinforced concrete members of relatively great length as compared with thickness, said members each spanning in staggered relation a plurality of bays intermediate the beams and means for securing each member to underlying beams to cause said beams and members mutually to reinforce each other.

8. A floor construction comprising a plurality of spaced steel beams and a continuous composite floor slab structurally united to said beams, said slab and beams serving mutually to reinforce each other, said slab comprising a plurality of precast, reinforced, concrete, plank-like members each of relatively great length as compared with its thickness, said members being supported side by side by said beams but separated from each other by a relatively small gap, each member being anchored to the underlying beams by fastenings exposed to said gaps and said members spanning each a plurality of bays intermediate said beams, said members having their end joints in staggered relation whereby each beam is overlapped by one or more adjacent members, and a surface covering of cement filling said gaps and bonding together into a continuous, homogeneous slab said units and the said fastenings.

9. A building construction comprising a plurality of spaced steel beams and a continuous composite load-supporting slab carried thereby comprising a plurality of separate pre-cast concrete plank-like members of great length as compared with thickness, said members spanning each a plurality of bays intermediate said beams, the width of the spanned space between the beams having a ratio to the thickness of said members of not less than thirty to one, means for fastening said members to said beams, and means for bonding said members together to form a continuous composite slab.

10. A floor construction comprising a plurality of spaced steel beams and a continuous composite floor slab structurally united to said beams, said slab and beams serving mutually to reinforce each other, said slab comprising a plurality of pre-cast, reinforced, concrete, plank-like members each of relatively great length as compared with its thickness, said members being supported side by side on said beams and spanning each relation a plurality of bays intermediate said beams, said members having their end joints in staggered relation whereby each beam is overlapped by one or more adjacent members, fastenings for anchoring each member to the underlying beam on which it has bearing, and means for bonding together said members into a continuous homogeneous slab.

In testimony whereof, I have signed my name to this specification.

EDWARD A. TUCKER.

## CERTIFICATE OF CORRECTION.

Patent No. 1,799,400. Granted April 7, 1931, to

EDWARD A. TUCKER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, lines 106 and 107, claim 10, strike out the word "relation"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of May, A. D. 1931.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)