Jan. 1, 1929. 1,697,070

H. M. KNIGHT

FLOOR

Filed Aug. 10, 1921 2 Sheets-Sheet 1

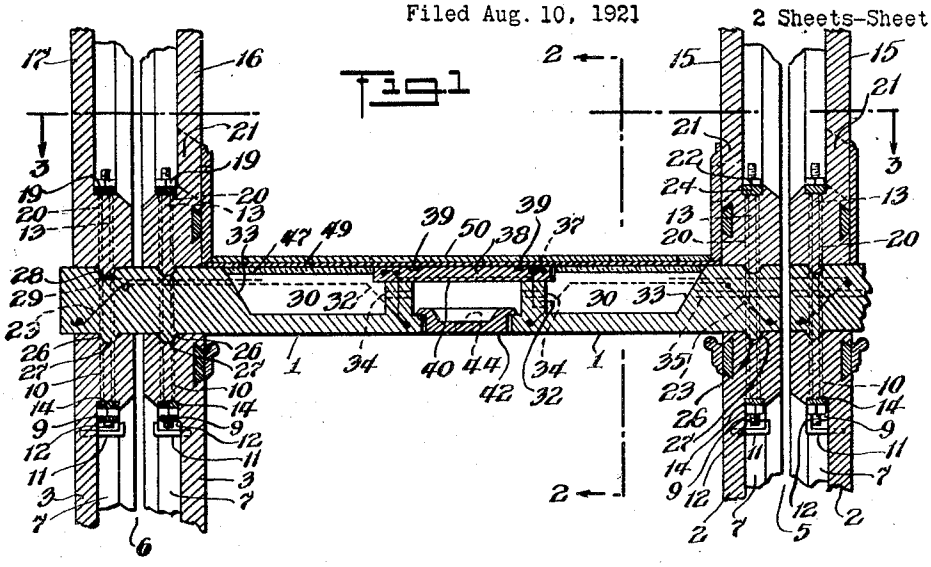


Fig. 1.

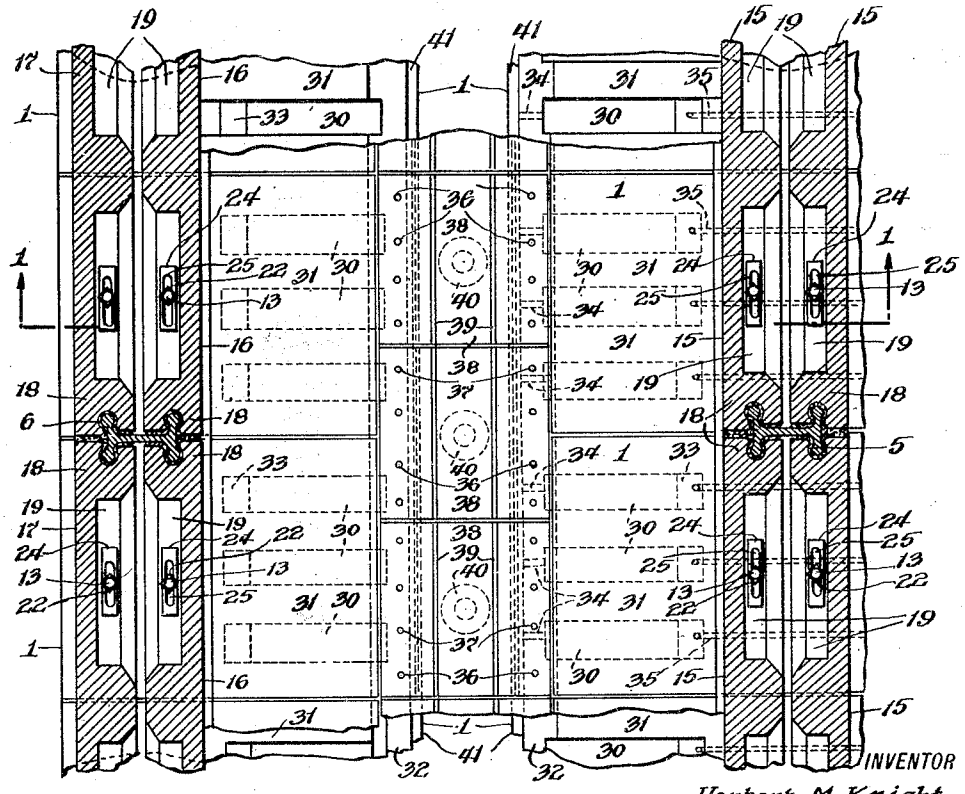


Fig. 2.

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FLOOR

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Fig. 2.

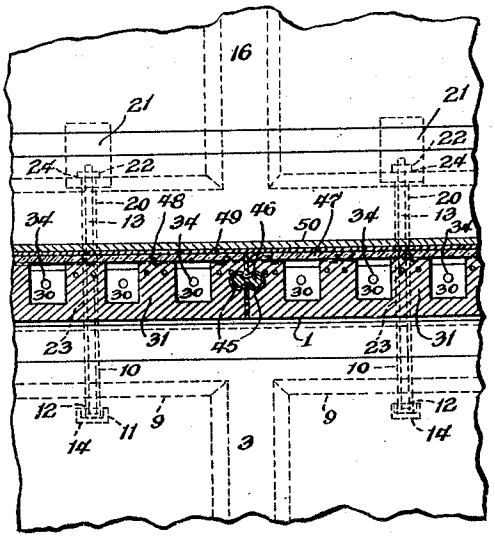


Fig. 4.

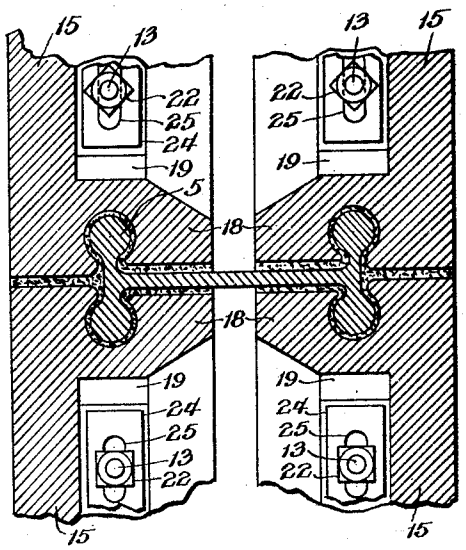


Fig. 5.

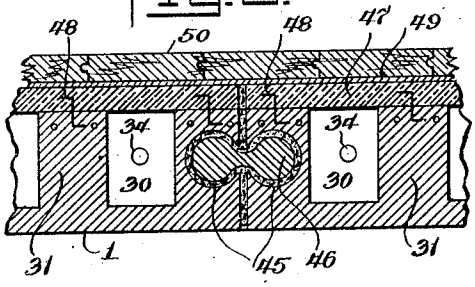


Fig. 6.

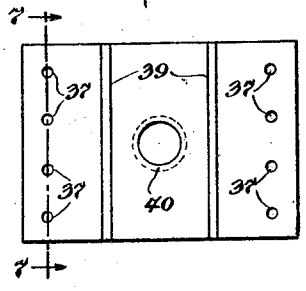


Fig. 7.

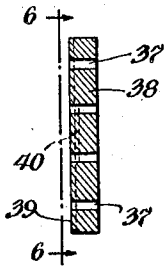


Fig. 9.

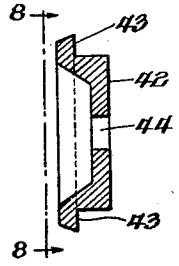
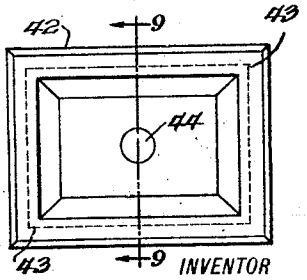


Fig. 8.



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Patented Jan. 1, 1929. 1,697,070

UNITED STATES PATENT OFFICE.

HERBERT M. KNIGHT, OF MONTCLAIR, NEW JERSEY.

FLOOR.

Application filed August 10, 1921. Serial No. 491,225.

My invention relates to improvements in floors and has particular reference to floors of pre-cast concrete units of cellular type.

One of the objects of my invention is to produce a floor of cellular pre-cast concrete which is of the cantilever type. Another object of the invention is to produce a cellular, cantilever type pre-cast floor, having a floating floor resting upon and filling the space between opposite cellular units. A further object of the invention is to produce such a cellular, cantilever type of floor, with provisions therein for the location of electric and other channels or appliances, without the necessity of making openings or alterations in the units. Still another object of the invention is to provide a unit, pre-cast floor upon which a wearing flooring can be laid without the necessity of introducing rough flooring. Yet another object of the invention is the production of a floor constructed of pre-cast units the underside of which shall be flat. A further object is to provide a floor of pre-cast units which shall not require the use of floor beams or girders. Another object is to produce a floor constructed of pre-cast units which shall not require the introduction of forms during any portion of the installation. Still another object of the invention is to produce a floor constructed of pre-cast units which can be installed in connection with walls of pre-cast materials. Still a further object is to produce a floor of pre-cast units in which, due to the division of the floors into cantilevers supporting a central floating section, the stresses and bending moments will be reduced to a minimum, and below what would be the corresponding stresses and bending moments in a floor, the span of which would be the distance between the two opposite points of support. Other objects of the invention will appear from the following description and the accompanying drawings.

The accompanying drawings, Figs. 1 to 9 inclusive, are illustrative of the invention and indicate the usual and preferred embodiment thereof. They are however illustrative only and are not to be considered as illustrative of all types in which the invention may be embodied, nor as exclusive of other types than that indicated.

I illustrate my invention by the accompanying drawings in which Fig. 1 is a cross section of a floor on the line 1—1 of Fig. 2. Fig. 2 is a longitudinal section on the line 2—2 of Fig. 1. Fig. 3 is a plan view on the line 3—3 of Fig. 1. Fig. 4 is an enlarged section of a joint between wall plates resting upon a floor. Fig. 5 is an enlarged cross-sectional view of a joint between the floor units. Fig. 6 is a plan view of the floating floor unit on the line 6—6 of Fig. 7. Fig. 7 is a cross-section of a floating floor unit on the line 7—7 of Fig. 6. Fig. 8 is a top plan view of a ceiling plug for use with this type of pre-cast floor, on the line 8—8 of Fig. 9 and Fig. 9 is a cross-section of such a ceiling plug on the line 9—9 of Fig. 8.

Referring to the drawings in which similar figures refer to similar parts. A pre-cast floor slab 1 projects from and is supported by inner pre-cast bearing-wall slabs 2 and outer wall slabs 3 and 4. The bearing-wall slabs are in multiple and are connected together by the key 5, while the exterior wall slabs are connected together by the key 6. Both outer and bearing-wall slabs have thickened edges 7 around their perimeters with key-ways 8 in the vertical edges for the insertion of the keys 5 and 6. Shoulders 9 are formed upon the upper surfaces of the thickened edges of the supporting slabs and elongated holes 10 pass through said edges. Nut housings 11 are cast in the back of the supporting slabs, positioned to receive and hold a nut 12 before the assembling of the supporting slabs, and to facilitate the entrance of a bolt 13 into said nut after the assembling of the slabs. Washers 14 with elongated holes therein are interposed between said shoulders and said nuts. Inner superimposed pre-cast bearing-wall slabs 15 rest upon the floor units 1 and outer pre-cast wall slabs 16 and 17 are superimposed upon the outer end of the unit 1 above the slabs 3 and 4. The said slabs 15, 16 and 17 have thickened peripheral edges 18 and keys 5 and 6 unite together the units composing the outer and inner walls respectively. Shoulders 19 are formed upon the upper surfaces of the horizontal thickened edges of the superimposed wall slabs and elongated holes 20 pass through said horizontal edges. Windows 21 are left open during the casting of the superimposed wall slabs through which to introduce the bolt 13 and through which also to place and tighten the nut 22 upon the bolt 13. Elongated holes 23 pass through the floor unit 1 so positioned as to register with the holes 10 in the lower, or supporting slab

and holes 20 in the upper or superimposed slab, the result of the screwing of the bolt 13 into the housed nut 12 and of the tightening of the nut 22 upon the washers 24 having an elongated hole 25 therethrough, is to permanently fasten together the supporting and superimposed slabs and the floor unit and to hold the cantilever floor unit suspended horizontally from the said walls. Tongues 26 are formed upon the lower face of the floor unit adapted to rest in grooves 27 in the upper horizontal thickened edges of the supporting slabs, and tongues 28 are cast in the lower thickened edges of the superimposed slab adapted to engage grooves 29 cast in the upper face of the floor unit, such tongues 26 and 28 and such grooves 27 and 29 serving to position the floor slabs. Cells 30 are formed in the body of the floor unit 1 with ribs 31 separating the said cells and front dams 32 and rear dams 33 closing the same. Apertures 34 pass through the front dam and apertures 35 through the rear dam for the passage of wires or pipes. Pins 36 project upwardly from the front dam registering with holes 37 in the pre-cast floating section 38. Nailing strips 39 are embedded in the pre-cast floating section and an insert 40 is cast into the lower face thereof. A ledge 41 projects from the cantilever floor slab adapted to receive and support a ceiling plug 42 having an overlapping edge 43 and a perforation 44 therein. Grooves 45 are cast in the edges of the cantilever floor slab, which, when alined, permit of the insertion of a key 46 along the edges of the juxtaposed floor units. A fibrile layer 47 covers the cells 30 and the medial ribs 31 with anchors 48 attaching said fibrile layer to said ribs. A deadening layer 49 is interposed between the fibrile layer and a wearing layer 50.

In the usual process of erecting building composed in whole or in part of reinforced concrete it is customary, in the case of the floors and the roofs, to erect a temporary forming, covering the entire floor or roof area, and to pour mass concrete upon the temporary forming so erected, which said forming is subsequently removed when the concrete shall have hardened sufficiently to permit such removal. Such floors are usually of the slab type of construction, either of beam and girder or of flat slab form, and are solid. For the purposes of lightness and economy void spaces are sometimes created within the floor slab by the introduction, in advance of the pouring of the concrete, of cellular elements, either of terra-cotta, iron, or similar materials, which, being surrounded by the mass concrete during the placing thereof, are embedded in the mass, thereby creating a cellular form of floor or roof construction. But all of these types or variations in floor or roof construction are mass floors or roofs, that is, they are created by the pouring of mass or liquid concrete upon a temporary forming, either with or without means for producing lightness and securing economy.

Such methods lead to great waste due to the use of large quantities of lumber in the temporary forming and its supporting means, and also consume a large amount of time of skilled and high priced labor in the erection of this forming. It is evident that the temporary forming has no use as a part of the permanent structure, and, that it has to be erected and demolished for every floor and for the roof, if it be of concrete. Unless an excessive amount of lumber is employed, sufficient to provide at one time for the forming for all of the floors, delays ensue while waiting for the floor or floors previously poured to set up sufficiently to permit of the safe removal of the forming thereon employed, a loss of time which, when represented in money, may be very great. As it is necessary to retain the skilled labor employed in forming operations during the enforced delay, and to employ them oftentimes on other and less remunerative activities, it is seen that the process of pouring mass concrete floors is one in which great delays and undesirable and often prohibitive costs are almost sure to occur. Again, both because of the character of the concrete and the usual exposure of the beams and girders and when it is desired to have a flat ceiling, it is necessary to add such a ceiling below the floor slab or to plaster the entire lower face thereof in order to secure a satisfactory appearance. When the floor is installed in a structure of the steel skeleton type, these delays and excess costs are somewhat reduced due to the ability to suspend the temporary forming from the steel members, but the cost of the steel is heavy and such construction is only adapted to use in tall and expensive buildings.

This invention seeks to remove and overcome the foregoing mentioned defects by means of a pre-cast unit type of floor or roof which is installed in the building without the necessity of temporary forming, permitting of the immediate introduction of the floor or roof and its fastening in position, allowing of construction to proceed without interruption, delay or unremunerative costs. The units, of which the floor is composed, are pre-cast, that is, the concrete is poured in advance of the location of the slab or unit in its position in the floor or roof, the unit, after hardening, being lifted to and secured in final location in the floor or roof. It is apparent that this type of construction requires only an initial form, which, due to the units being in all respects similar, can be used indefinitely without destruction and that units can be produced indefinitely and continuously without waste or expensive delays.

In the usual types of pre-cast floors, the

units are solid, no provision being made to secure lightness by the use of void or cellular producing means. Such units are cumbersome and heavy to handle, and often, because of the length of the span required, prohibitive in practice. In order to obviate these apparent defects in pre-cast floor units, a cellular type of unit is employed, cavities or voids being formed in the body of the unit by the use of void producing means, which being of very light weight material may be allowed to remain in the unit after it shall have been poured or cast. A sufficiency of concrete to give the necessary strength in compression is used in the base and in the division between the cells, and the reinforcing steel so distributed in the medial ribs as to obtain the required strength in tension. A very light and strong type of construction results, and one which can be economically and expeditiously constructed. Provision is made by means of apertures through the terminal walls of the cells for the passage of electric wires, pipes, etc., a form of construction which removes the necessity of enclosing electric or other wiring in conduits or other fire protective channels.

Due to the fact that the usual type of floor or roof construction is a slab continuous between supports, upon which it rests at either end, stresses are set up which while determinable, are high. These stresses are reduced when a cantilever type of floor, divided and supporting a floating section is employed. The combination of such a cantilever type of a cellular section, results in the strongest and lightest form of construction, such combination being that illustrated and described in this invention. In the case of a simple slab, either continuous or non-continuous over supports, compression exists in the top of the slab and tension in the bottom, this tensile stress being resisted by the steel reinforcement introduced in the bottom of the slab for that purpose. In the case of the pre-cast cantilever unit these stresses are reversed, that is, the top of the unit is in tension and the bottom in compression. Due to this distribution of the stresses it is possible, with the cellular form of construction, to provide for their resistance with the greatest facility. The bottom of the unit being a solid layer of concrete resists the compressive stresses set up therein, while the tensile stresses are met by the reinforcement embedded in the upper portion of the medial ribs between the cellular elements. Again, as the maximum bending moments are at the point of support, it is possible to easily increase the amount of reinforcement in the top of the medial ribs at this point, to meet these augmented stresses, without carrying it throughout the entire length of the unit, and a great economy in the use of steel results.

In the type of cellular cantilever floor unit illustrated two conjunctive means are used to secure the slab at the points of support. The units are perforated, permitting the passage of a bolt, which, by engaging suitably positioned shoulders, either below the unit, or both above and below, secure it in position and protect it against an overturning moment around its point of support. In addition to and in conjunction with this positive holding down means, the walls above the point of support rest upon the end of the floor slab unit, and by their weight constitute an additional means of securing the unit to its support.

In this invention the cantilever units constituting the floor cover only a portion of the floor or roof area, and in no instance is the length of a unit half of the floor span. Therefore the weight borne directly by a unit is never one-half of the floor loads and weights of the floor area which it is tributary to, and consequently the weight borne directly by the individual unit and transmitted directly by it to the point of support is comparatively small. A gap is purposely introduced between the separated ends of the floor units, so that the units on opposite sides of the opening act independently, all stresses reaching or arising upon one of the units being transmitted directly to its point of support, the two units and two points of support acting independently, and not in conjunction as is the case with a single or continuous beam spanning the opening between supports.

The opening between the separated cantilever units is closed by a floating floor section resting upon a ledge cast in the outer edge of the supporting unit, and having holes along two of the opposite edges of the floating section positioned to receive projecting pins cast into the supporting unit, which pins, by the subsequent cementing up of the holes serve to retain the floating section accurately and immovably upon the cantilever unit, and, while not modifying the action of the floating unit in its character of a simple slab supported at either end by the cantilever unit, aid in the transmission of the weight carried by the floating unit to the cantilever unit and through it to the point of support. The span of the floating section always being small its thickness can be materially reduced below the thickness required in a slab which spans the entire distance between the primary points of support, and also the amount of reinforcing steel is reduced. The net result is a large reduction in the amount of material required for the floating member with a consequent large reduction in its weight and an accompanying reduction in the amount of reinforcement, conditions which make for economy both in the floating unit and in the cantilever unit by which it is supported. A further feature of the floating unit is the

casting thereinto during its pouring of an insert of wood or similar material, upon the undersurface thereof as it is positioned in the floor for the attachment of lighting or other fixtures which it may be designed to suspend from the ceiling below the said floor. As previously mentioned, apertures are provided in the ends of the cells of the cantilever units so that it is possible to suspend connection boxes from the insert on the lower side of the floating unit and to lead wires thereto from the walls through the cells of the cantilever units, and, in view of the incombustible character of all of the material employed, and to dispense with wire conduits.

The cellular cantilever units are constructed with an extending ledge on the lower face adjacent to the gap or opening between the said cantilever sections, upon which ledge rests a ceiling plug of concrete or similar material, designed to close the lower side of the opening between the cantilever units and to present an even, flat effect. This plug may be perforated, as indicated, for the purpose of introducing therethrough lighting or other devices which may be suspended from the ceiling.

The covering of the cells of the cantilever units need not be of a character to resist either tensile or compressive stresses, as such stresses are resisted by the concrete and reinforcement below the tops of the mid-ribs separating the cells. Accordingly the cells are covered with a material of lesser strength than that of stone, gravel or cinder concrete, and, preferably, as indicated, by a concrete composed in part of fibrous material, which will admit of nails or similar fastenings being driven therein, thereby attaching the wearing floor of wood or similar material to the concrete floor units, an intermediate layer of paper or other desired insulating material being introduced between the wearing floor and the concrete units. Metal or other ties are employed to insure the adherence of the fibrous concrete to the concrete making up the body of the cantilever units.

While a floor system of such floating and cantilever units is applicable to any form of building construction which offers a means of satisfactorily and securely anchoring the units to the walls or other support, the system has been particularly designed for use in connection with a system of unit concrete construction in which pre-cast concrete wall slabs or units are employed. Such construction as is here indicated consists in the use of double walls of slabs provided with thickened edges around the peripheries thereof, such thickening providing a shoulder against which a nut or washer can rest. Elongated holes for the passage of bolts perforate these thickened edges at predetermined points. Similar holes pass through the cantilever floor slabs, the backs of which slabs extend beyond the face of the wall and are supported upon the thickened edges of the wall units below the floor. Other wall units are superimposed upon the floor units in position, and, the bolt holes of the supporting and superimposed wall units and the holes in the floor units being in registration, bolts are introduced, passing through said registering holes, and, by the tightening of nuts upon said bolts upon washer plates in contact with the upper and under shoulders of the thickened edges of the wall units, the whole structure is fastened permanently together. Such, and so many floors, as also the roof, may thus be installed in a building, and a light and strong character of construction secured.

While in the above described system of construction, unconnected floor units are of feasible employment, it is desirable, in order to secure a stronger and more regular floor, to connect the adjacent cantilever units. Such connection is made by means of a key, cemented in a key-way, or re-entrant groove which is cast in the lateral edges of the floor units during their pouring. The lateral edges of the floor units are all similarly provided with such re-entrant grooves, which, being brought into juxtaposed alinement, when the units are erected in position, permit of a key being inserted thereinto, connecting the adjacent floor units, and by the use of cement mortar in said grooves, fastening the said adjacent units together, resulting in all of the units on the same side of the central gap acting as one.

For the purpose of securing, so far as it may be possible in a unit type of structure, a monolithic construction, the wall units are fastened together by keys, inserted and cemented into key-ways cast in the thickened edges of the wall units. Such uniting of the wall units in connection with the holding-down bolts which unite the wall and floor slabs results in a structure in which all portions act together in sustaining pressures and in supporting weights.

For the purpose of accurately and rapidly positioning the wall and floor units, tongues and grooves are cast in the contact faces thereof, which, by their registration, serve to immediately and accurately locate the several wall and floor units during assembly.

Such a system of pre-cast floors or roofs, erected without the use of temporary constructions, in which, for the double purpose of ease in assembling and for increase of strength, a gap is interposed between opposing sections, such gap being bridged by a floating section resting upon the inner edges of the supporting sections, the supporting sections being of cellular type, retained in position by the conjunctive operation of holding-down bolts and superimposed wall sec-

tions, permits of rapid and continuous construction and results in a very light and strong type of floor or roof.

What I claim is:—

1. In a building construction, the combination of walls and floors constructed of pre-cast units, marginal portions of floor units adjacent to the walls being inserted between upper and lower wall units, and means secured in pre-cast portions of the upper and lower wall units, said means extending through pre-cast portions of the floor unit whereby the upper and lower wall units cooperate with the said means to provide the entire support for said floor unit.

2. In a building construction, the combination of walls and floors constructed of pre-cast units, marginal portions of floor units adjacent to the walls being inserted between upper and lower wall units, and bolts secured in pre-cast portions of the upper and lower wall units, said bolts extending through pre-cast portions of the floor unit whereby the upper and lower wall units cooperate with the said bolts to provide the entire support for said floor unit.

3. In a floor system, a multiple of pre-cast cellular floor units, a wall supporting one end of said units, thickened edges on the upper portion of said supporting wall, a wall superimposed upon said units and above said supporting wall, thickened edges on the lower portion of said superimposed wall and bolts passing through said thickened edges of said supporting and superimposed walls and through said units.

4. In a floor system, a multiple of pre-cast cellular floor units, means supporting one end of said units, thickened edges on the upper portion of said supporting means, a body superimposed upon said units and above said supporting means, thickened edges on the lower portion of said superimposed body, means insertible after assembly of said parts tying said supporting means and said superimposed body and said units together, said superimposed body having apertures, said apertures being contiguous to and above said tying means enabling said tying means to be inverted after assembly of the parts.

5. In a floor system, a multiple of pre-cast cellular floor units, means supporting one end of said units, thickened edges on the upper portion of said supporting means, a body superimposed upon said units and above said supporting means, thickened edges on the lower portion of said superimposed body, bolts tying said supporting means and said superimposed body and said units together and nuts embedded in said supporting body upholding and retaining said tying means.

6. In a floor system, a multiple of pre-cast cellular floor units, means supporting one end of said units, thickened edges on the upper portion of said supporting means, a body superimposed upon said units and above said supporting means, thickened edges on the lower portion of said superimposed body, means tying said supporting means and said superimposed body and said units together and positioning means locating said units relative to said supporting means and to said superimposed body.

7. In a floor system, a multiple of pre-cast cellular floor units, means supporting one end of said units, thickened edges on the upper portion of said supporting means, other floor units and other supporting means having thickened upper edges oppositely disposed to said units and supporting means, the combined length of said oppositely disposed units being less than the total distance between said oppositely disposed supporting means, bodies superimposed upon said oppositely disposed units and above said oppositely disposed supporting means, said superimposed bodies having thickened edges on the lower portions thereof, means tying said supporting and superimposed bodies through said thickened portions and said units together, and floating sections spanning the opening between the unsupported ends of said oppositely disposed units, said sections being supported by said units.

8. In a floor system, a multiple of pre-cast cellular floor units, means supporting one end of said units, thickened edges on the upper portion of said supporting means, other floor units and other supporting means oppositely disposed to said units and said supporting means, the combined lengths of said oppositely disposed units being less than the total distance between said oppositely disposed supporting means, bodies superimposed upon said oppositely disposed units and above said oppositely disposed supporting means, said superimposed bodies having thickened edges on the lower portions thereof, means tying said supporting and said superimposed bodies and said units together, floating sections spanning the opening between the unsupported ends of said oppositely disposed units, said sections being supported by said units and positioning means locating said units and said sections relative to each other.

9. In a floor system, a multiple of pre-cast cellular floor units, means supporting one end of said units, other floor units and other supporting means oppositely disposed to said units and said supporting means, the combined length of said oppositely disposed units being less than the total distance between said oppositely disposed supporting means, bodies superimposed upon said oppositely disposed units and above said oppositely disposed supporting means, means tying said supporting and said superimposed bodies and said units together, ribs in said units, front dams in said units, pins embedded in said ribs and in said dams, a float-

ing section spanning the opening between the unsupported ends of said oppositely disposed units and depressions in said floating section registering with an telescoping upon said pins,

10. In a floor system, a multiple of pre-cast cellular floor units, grooves in the longitudinal edges of said units, said grooves of juxtaposed units being in alinement, keys in said grooves, means supporting one end of said units and said supporting means oppositely disposed to said units and said supporting means, the combined lengths of said oppositely disposed units being less than the total distance between said oppositely disposed supporting means, bodies superimposed upon said oppositely disposed units and above said supporting means, means tying said supporting and said superimposed bodies and said units together and floating sections spanning the opening between the unsupported ends of said oppositely disposed units, said sections being supported by said units.

11. In a floor system, the combination of a multiple of pre-cast cellular floor units, grooves in the longitudinal edges of said units, said grooves of juxtaposed units being in alinement, keys in said grooves, means supporting one end of said units, thickened edges on the upper portion of said supporting means, other floor units and other supporting means oppositely disposed to said units and said supporting means, the combined lengths of said oppositely disposed units being less than the total distance between said oppositely disposed supporting means, bodies superimposed upon said oppositely disposed units and above said supporting means, said superimposed bodies having thickened edges on the lower portion thereof, means tying said supporting and said superimposed bodies and said units together and floating sections supported by said units and spanning the opening between the unsupporting ends of said oppositely disposed units.

12. In a floor system, the combination of a multiple of pre-cast cellular floor units, ribs between said cells, front dams to said cells, rear dams to said cells, sides to said units, alined re-entrant grooves in the juxtaposed sides of adjacent units, keys in said aligned grooves, means supporting one end of said units, other floor units and other supporting means oppositely disposed to said units and said supporting means, the combined length of said oppositely disposed supporting means, bodies superimposed upon said oppositely disposed units, means tying said supporting and said superimposed bodies and said units together and floating sections spanning the opening between the unsupported ends of said oppositely disposed units and resting upon said units and ceiling plugs beneath said floating sections supported by said units.

13. In a floor system, the combination of a multiple of pre-cast cellular floor units, ribs between said cells, front dams to said cells, rear dams to said cells, sides to said units, alined re-entrant grooves in the juxtaposed sides of adjacent units, keys in said aligned grooves, means supporting one end of said units, other floor units and other supporting means oppositely disposed to said units and said supporting means, the combined length of said oppositely disposed units being less than the total distance between said oppositely disposed supporting means, bodies superimposed upon said oppositely disposed units, means tying said supporting and said superimposed bodies and said units together, floating sections spanning the opening between the unsupported ends of said oppositely disposed units and resting upon said units, ridges upon the unsupported ends of said units and ceiling plugs resting upon said ridges.

Signed at New York, in the county of New York and State of New York, this ninth day of August A. D. 1921.

HERBERT M. KNIGHT.