April 11, 1961 M. S. YOLLES 2,979,169

BUILDING STRUCTURE

Filed Aug. 16, 1954 3 Sheets-Sheet 1

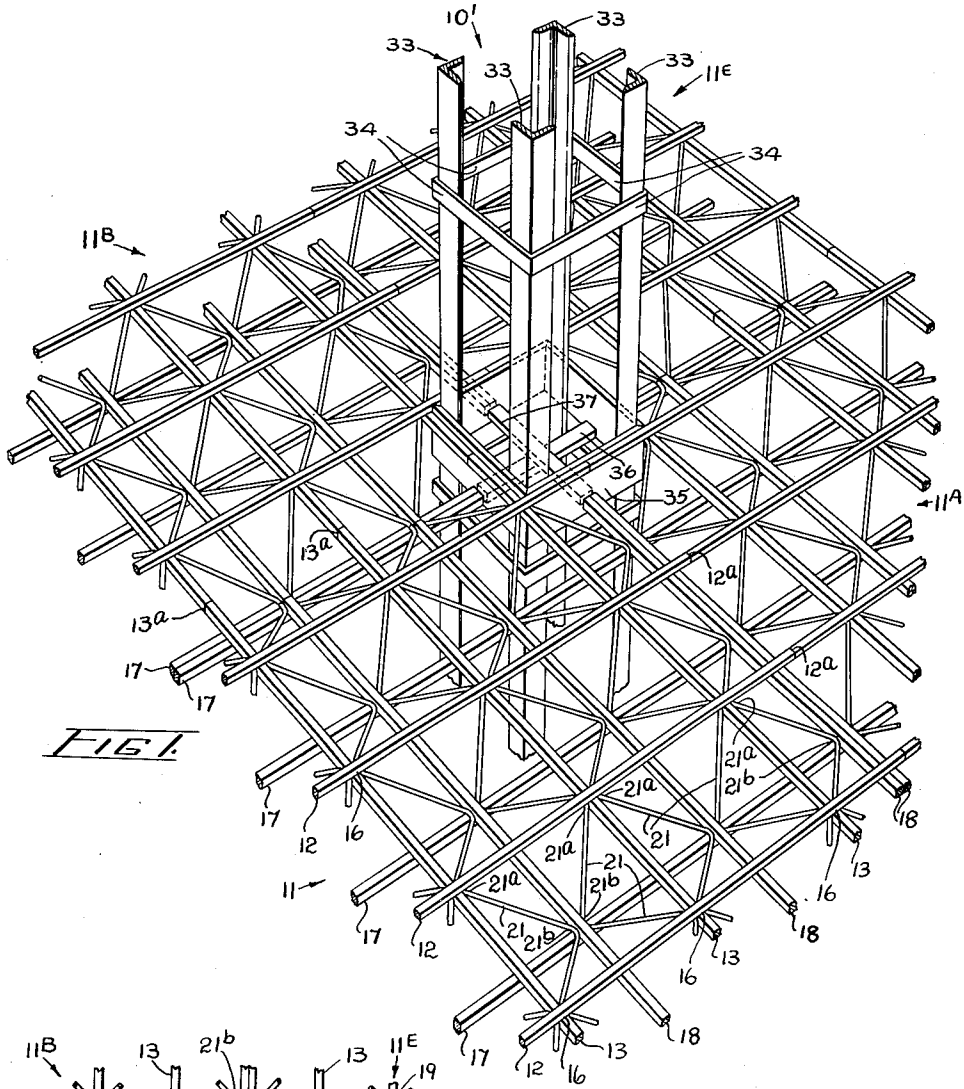


FIG. 1.

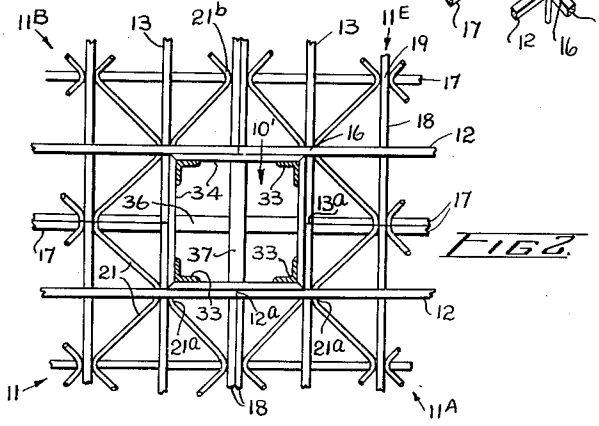


FIG. 2.

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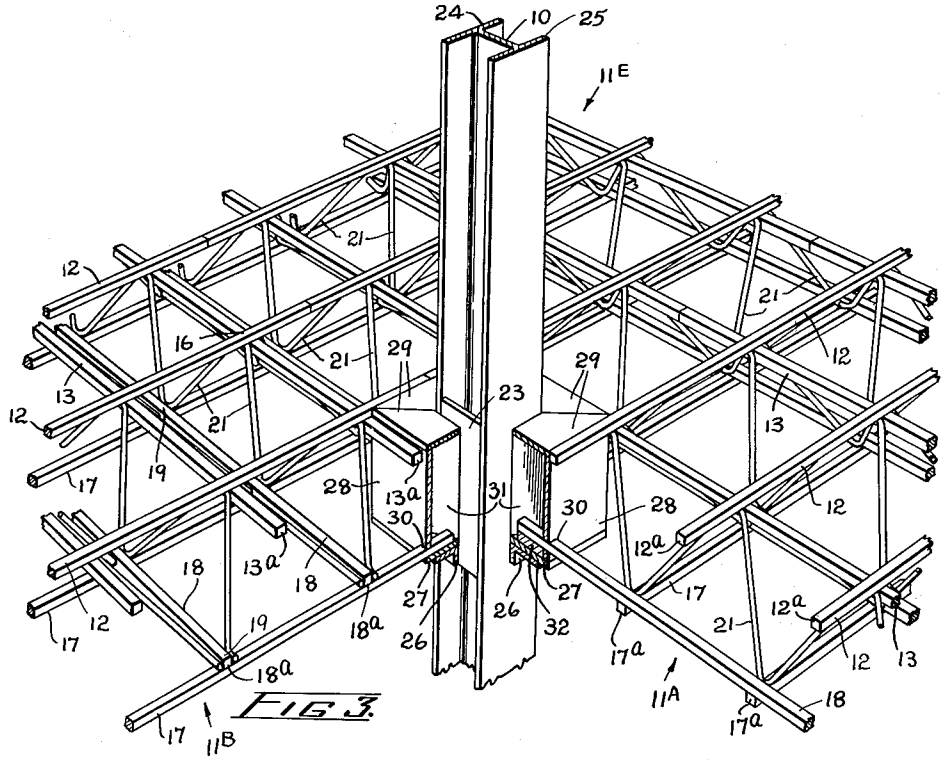


FIG 3.

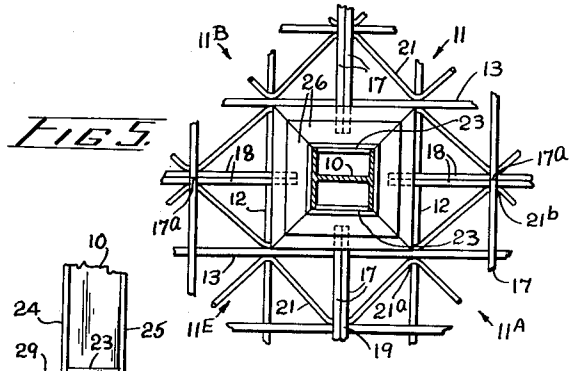


FIG 5.

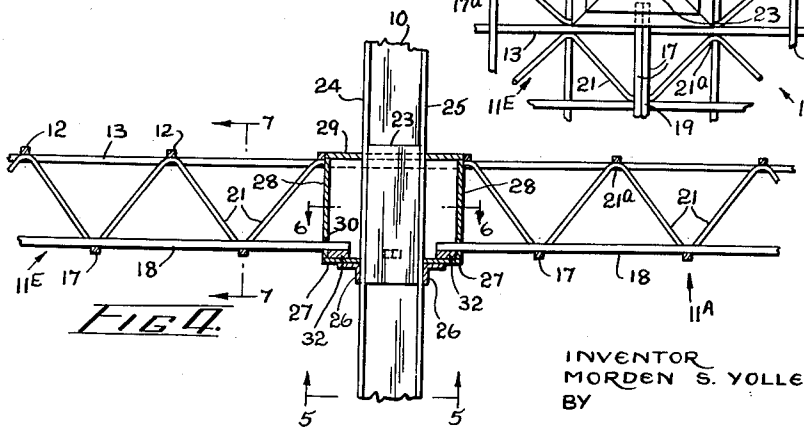


FIG 4.

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BUILDING STRUCTURE

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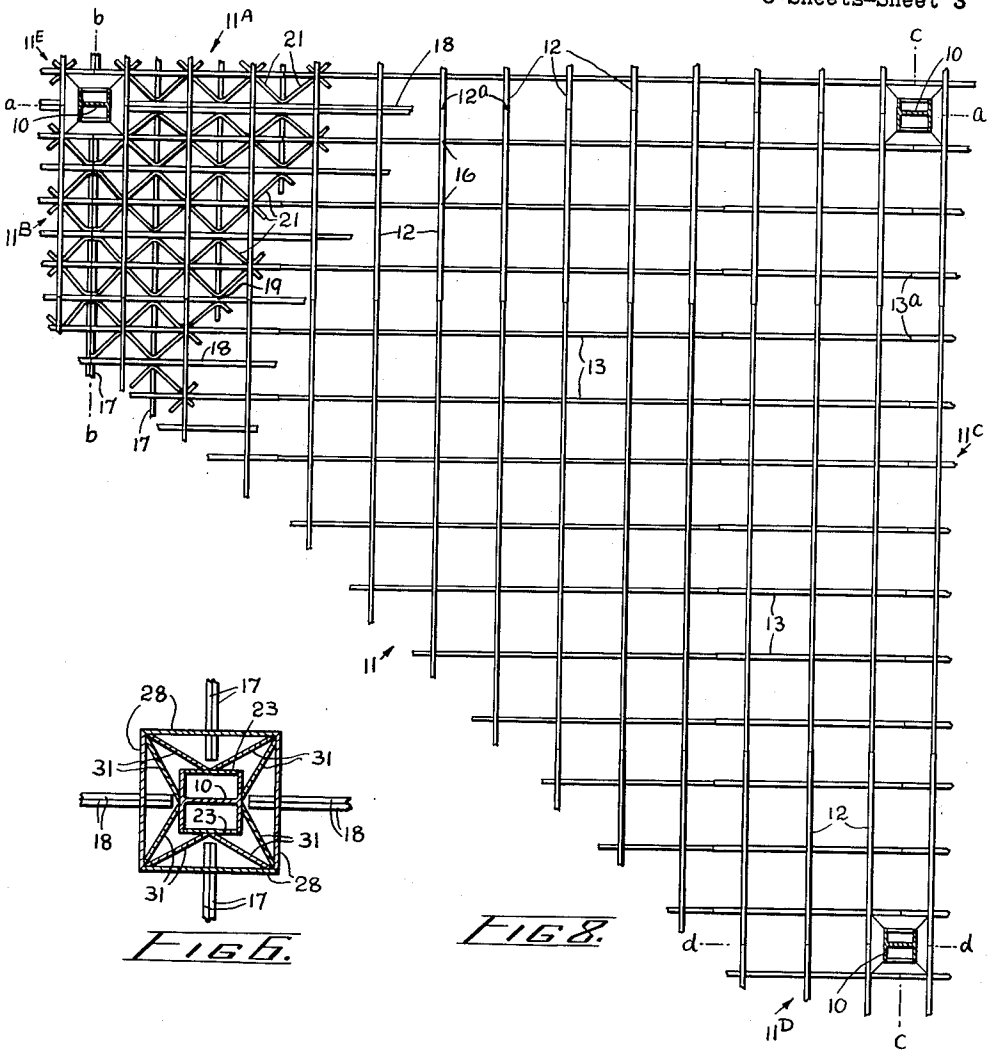


FIG 8.

FIG 6.

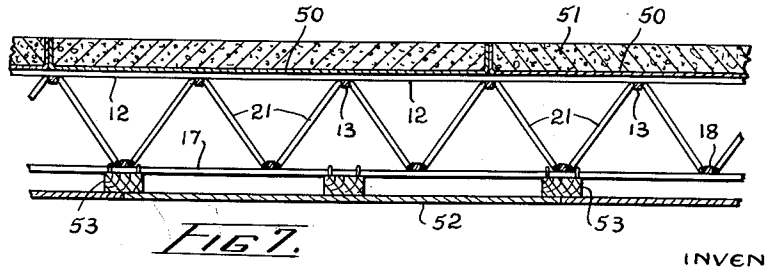


FIG 7.

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United States Patent Office 2,979,169 Patented Apr. 11, 1961

2,979,169

BUILDING STRUCTURE

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Filed Aug. 16, 1954, Ser. No. 450,049

7 Claims. (Cl. 189—34)

This invention relates to structural units for use in building construction and to a building framework including such units.

The erection of buildings having large floor or roof areas has been expensive and time consuming, and one important factor contributing to the expense and delay has been the use of small structural components, such as beams, trusses, girders, purlins, joists and braces which are assembled during the erection of the building to form the floor and roof structures. Conventional bulky structures present many problems in fire proofing, sound transmission, and in the locating and concealing of ducts and conduits.

It is an object of this invention to provide a prefabricated floor or roof unit which can be constructed at some convenient location and then shipped to the construction site where it can be set in place with a minimum of time and labour.

It is another object of this invention to provide a unit that is simple to construct and that can conveniently be made in a number of shapes and sizes.

It is another object to provide a unit that is adapted to co-operate with, and be secured to, other similar units to form a rigid integral structure.

It is another object to provide a unit that is light in weight and yet of great strength.

It is another object to construct a unit in such a way that it reduces sound transmission and may house ducts and conduits which conventionally must be located in false floors or ceilings.

It is another object to provide a unit, the construction of which is adapted to "jig" techniques and the use of standard, easily obtainable structural members and machines.

It is another object to provide a prefabricated unit which is adapted for use with a great many construction methods and in buildings of many different types.

It is another object to provide for use with such floor or roof units a supporting column structure facilitating quick, economical erection.

In conventional building construction, columns support primary load carrying horizontal members (beams and girders) which in turn support a secondary flooring system. It is another object of the invention to provide a building framework that is beamless, i.e., free of the primary individual members like beams and girders that are solid and of appreciable depth.

The present invention envisages prefabricated grid units which may be made on the building site or elsewhere while the preliminary work on the building structure, such as the laying of the foundations and the erection of the columns of the building, is in progress. The prefabricated units can be brought to the building site and easily hoisted and secured into position.

Grid units according to the invention effect a saving in weight over conventional steel framing of the order of 35%, and over conventional concrete slab or shell construction there may be a 90% weight saving. Lighter

supporting columns may be used, thereby further reducing building costs.

The units have free spaces between the grids, allowing the placement of all ducts and conduits (such as air-conditioning ducts, plumbing pipes, and electrical conduits) within the units, thus obviating the need for false floors or ceilings to house such ducts and conduits. Elimination of false beams and ceilings allows a reduction in floor to floor height and effects a further reduction in cost. It is relatively easy to alter the ducts and conduits if this becomes necessary. Since the grid units are hollow, and require no beams to support them, the need for conventional fireproofing (encasing steel beams in concrete to prevent buckling when subjected to high temperatures) is eliminated. An extremely important advantage of being able to eliminate supporting beams is that there is no obstruction to the passage of ducts and conduits between the grids during either the erection of the building or during subsequent alterations to it.

The units, due to their grid-like structure and light weight, may be used in combination with simply erected hollow supporting columns in which vertical ducts and conduits can be housed, thus saving additional valuable space and locating the ducts and conduits where they are most convenient.

The provision of standard prefabricated units in a number of sizes simplifies the construction of various types of buildings. The units may be made in curved form for use in arched roof construction, for example, in aircraft hangars where a large floor area is required uninterrupted by supporting columns.

These and other advantages of the invention will be evident from the following description of specific examples of the invention. Reference is made to the accompanying drawings, in which like reference numerals denote like parts in the various views, and in which:

Fig. 1 is a fragmentary perspective view of a vertical column supporting corners of four prefabricated units made in accordance with this invention;

Fig. 2 is a top view of the column and units of Fig. 1;

Fig. 3 is a fragmentary perspective view of a different type of column, showing corners of three floor units;

Fig. 4 is a partly sectional side view of the column and units of Fig. 3;

Fig. 5 is a bottom view of the column and units of Figs. 3 and 4, showing four units in place;

Fig. 6 is a sectional view along the line **6—6** of Fig. 4;

Fig. 7 is a sectional view along the line **7—7** of Fig. 4 and showing, in addition, possible floor and ceiling structures supported by the prefabricated units; and

Fig. 8 is a top view showing portions of a typical four-cornered bay, three columns of the bay being shown.

In the following description the terms upper and lower are used for convenience since the prefabricated units illustrated are horizontal, but it will be understood that use of these terms is not intended to exclude structures in which the units may be inclined or arched.

Referring first to Fig. 8, there is shown a typical floor bay having vertical columns **10** at the corners (only three corners being shown), the columns supporting a horizontal, open, lattice-like structure. Most of the horizontal structure shown in Fig. 8 consists of a single prefabricated steel unit indicated generally as **11**, this unit being abutted at its periphery, along lines *a—a*, *b—b*, *c—c*, and *d—d* through the centre lines of the columns, by similar units **11A**, **11B**, **11C**, **11D**. If a unit **11** capable of filling an entire bay is too large to be conveniently handled, a plurality of smaller prefabricated units may be used.

At any column (such as a column **10** in Figs. 3–5 or 8, or the column **10'** in Figs. 1 and 2) the corners of

four units such as 11, 11A, 11B and 11E are supported. Each of these units is made up of an upper and a lower grid lying in spaced parallel planes, each grid consisting of sets of rods running at right angles to each other and secured together at their intersections. Thus, the upper grid consists of a set of coplanar, parallel, rods 12, spaced apart at equal intervals, and beneath the rods 12 and at right angles to them is a similar set of rods 13. The rods 12 rest on the rods 13 and are welded to the rods 13 at each intersection 16. The lower grid consists of a lower set of rods 17 and an upper set of rods 18, parallel respectively to the rods 12 and 13 of the upper grid. The rods 17 and 18 are welded together at their cross-over points 19. The grids are of such length and breadth that the distances between adjacent crossings 16, 16 or 19, 19 are short compared to the lengths of individual rods 12, 13, 17 and 18 and compared to the distances between any of the columns 10 at the corners of the bays.

The upper and lower grids are in staggered relationship to each other, vertical planes which contain rods 12 being midway between vertical planes which contain rods 17, and vertical planes which contain rods 13 being midway between vertical planes which contain rods 18. Thus, as seen in Figs. 2, 5 and 8, the projection on the upper grid of an intersection 19 of the lower grids at the centre of one of the rectangular openings defined by the rods 12, 13 of the upper grid.

The bracing means which hold the upper grid and the lower grid in spaced parallel relationship are sinuous rods 21 which lie in planes inclined at approximately 45° to the grids, the rods 21 running in the same direction as the rods 13 and 18. Each rod 21 consists of a wave-like series of alternate peaks 21*a* and dips 21*b* connected by straight lengths of the rod 21, the peaks 21*a* being welded to the upper grid at the intersections 16, and the dips 21*b* being welded to the lower grid at the intersections 19. Adjacent rods 21 lie in planes that are inclined in opposite directions, alternate rods 21 lying in parallel planes. At each intersection 16 of a rod 12 and a rod 13 are peaks 21*a* of two adjacent rods 21, the peaks being secured at opposite sides of the lower rod 13 in contact with and supporting the upper rod 12. Similarly, at each intersection 19 of a rod 17 and a rod 18 are dips 21*b* of two adjacent rods 21, the dips being secured at opposite sides of the upper rod 18 in contact with and resting upon the lower rod 17. Thus any given rod 21 leans against a rod 13 and a rod 18, the horizontal thrust of the rod 21 against rods 13 and 18 being balanced by opposite thrusts of rods 21 at the opposite sides of the rods 13 and 18. It will be seen that any given intersection 16 is at the peak of an imaginary four-sided regular pyramid of which the straight length of the rods 21 form the inclined edges and rods 17 and 18 form the base. Similarly each intersection 19 is at the peak of an inverted four-sided regular pyramid, the four intersections 16 closest to the intersection 19 being at the corners of the base of the pyramid.

The outer boundaries of the rectangular unit 11 are defined by two rods 17 along two opposite edges of the unit and by two rods 18 along the other two edges. Along the edges bounded by rods 18, the rods 12 and 17 are cut off, as at 12*a* and 17*a* (Fig. 3) in vertical planes which contain the outer edges of the bounding rods 18, and similarly, along the edges bounded by rods 17, the rods 13 and 18 are cut off, as at 13*a* and 18*a*, in vertical planes which contain the outer edges of the bounding rods 17. Thus the upper grid is the same size as the lower grid. When two adjacent units, such as 11 and 11A, are butted together (Fig. 1) an outside rod 18 of one unit is in longitudinal contact with an outside rod 18 of the other unit, and these rods are welded together along their length. The rods 12 of the one unit abut end to end with the rods 12 of the adjacent unit, and these abutting rods are also welded together. Similarly when units such as 11 and 11B are butted together, outside rods 17 come together as do the ends 13*a* of the rods 13.

In Figs. 3 to 6 is shown a vertical column 10 to which corners of the grid units 11, 11A, 11B and 11E are secured. The column 10 is a conventional I-beam around which a box structure has been built to secure the grid units. Plates 23 are secured between the edges of the column's flanges 24 and 25. Secured around the column to the flanges 24 and 25 and to the plates 23 are angle brackets 26, and on the top surfaces of the brackets are secured four plates 27 which form the bottom of the box. Four vertical plates 28 welded to the outer edges of the bottom plates 27 form the side walls of the box, and four top plates 29 join the tops of the side walls 28 to the column 10. Vertical bracing plates 31 (Fig. 6) may be provided within the box to increase its strength.

The corners of the grid units are cut away to clear the column 10, and when the corner of a unit is swung into place the outside rods 17 and 18 in the lower grid project through apertures 30 in the side walls 28 and rest upon the four bottom plates 27, blocks 32 being placed under the rods 18 since they are higher than rods 17 by the thickness of the rods 17. The sides of the rods 12 and 13 contact the side walls 28 of the box. All contacting parts of the grid units and box structure are welded together. As best seen in Fig. 5, the contacting rods 17, 18 of abutting grid units are in line with the centre line of the column 10.

A preferred form of column 10′ is shown in Figs. 1 and 2. The column consists of four angle bars 33 set (in plan view) at the four corners of an imaginary square and held in this relationship by straps or braces 34 extending between the bars 33. For securing the grid units to the column, four plates 35 are welded to the angle bars 33, and rods 12 and 13 are welded along the upper edges of the plates 35, rods 17 and 18 abutting against and also being welded to the plates. Internal braces 36 and 37 may be set within the column to resist the compressive force of the rods 17 and 18. Since the column 10′ is hollow, duct work may be installed within it, and it is a simple matter to bring the duct work through the plates 35 (or to replace the plates with less obstructive securing means) to run ducts and conduits in any direction between the upper and lower grids of the grid units.

In Fig. 7 is shown one way of supporting a floor and a ceiling from a grid unit. For the floor, pans 50 may be laid adjacent one another and filled with concrete 51, the concrete being reinforced if desired. The ceiling may consist of plaster board 52 nailed to wooden strips 53 which are suspended from the lower grid. As seen in Fig. 7, the structure formed by the sinuous rods and the rods of the upper and lower grids is self-sustaining, i.e., it is capable of carrying loads without the aid of a mass of concrete or the like, loads being distributed in the directions of the rods 12 and 17, in the directions of the rods 13 and 18, and, by the sinuous rods 21, in other directions as well.

As generally indicated in Fig. 8, the rods 12, 13, 17, 18 and 21 adjacent the columns are larger in cross-section than they are at the centre of the bay, in order to equalize the stresses over the entire grid unit.

It will be seen that the prefabricated units and their supporting structures are simple and economical to construct, and result in a considerable saving in the erection costs of buildings with large floor areas. It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same, and that various changes in the shape, size and arrangement of the parts may be resorted

to without departing from the spirit of the invention or the scope of the subjoined claims.

What I claim as my invention is:

1. A beamless building framework having rectangular bays, comprising vertical columns at the corners of the bays, and an all metal open-lattice load-supporting beamless structure spanning the bays and secured to and supported solely by the columns at the corners of the bays, said structure comprising a plurality of all metal similar rectangular prefabricated grid units that abut and are secured together along their edges, each grid unit comprising an upper grid and a lower grid generally parallel to the upper grid and spaced therefrom, each grid comprising a first set of parallel rods and a second set of parallel rods, the rods of the first sets being parallel to the same edge of the grid unit, the rods of the second set of each grid crossing over the rods of the first set at right angles and being connected to the rods of the first set at the crossings, the first set of rods of the upper grid lying below the second set of rods of the upper grid, the first set of rods of the lower grid lying above the second set of rods of the lower grid, the distances between adjacent crossings being short compared to the lengths of individual rods of both the first and second sets and compared to the distances between any of the columns at the corners of the bays, the rods of the lower grid being staggered relative to the rods of the upper grid so that a plane containing a given rod of the lower grid and normal to the grids is substantially midway between the nearest parallel rods of the upper grid, and a plurality of sinuous rods between the grids and holding the grids in their spaced apart relationship, each sinuous rod lying in a plane that is inclined relative to the grids and that is parallel to the rods of the first sets, each sinuous rod consisting of a wave-like series of alternate peaks and dips connected by straight lengths of the rod, the sinuous rods at the dips being connected to the rods of the lower grid at the crossings of the lower grid where the dips contact and rest upon the rods of the second set of the lower grid and lean against the rods of the first set of the lower grid, the sinuous rods at the peaks being connected to the rods of the upper grid at the crossings of the upper grid where the peaks contact and support from below the rods of the second set of the upper grid and lean against the rods of the first set of the upper grid, adjacent sinuous rods leaning in opposite directions against opposite sides of the rods of the first sets at the crossings, the straight lengths of the sinuous rods defining, between a given crossing of rods of the upper grid and the four closest crossings of rods of the lower grid, the edges of an imaginary four-sided regular pyramid the base of which is defined by rods of the lower grid and the vertex of which is at the given crossing, said structure being capable of distributing loads in at least the directions of the rods of both the first and second sets and providing, within bays and from bay to bay, space between the upper and lower grids for passage of ducts and conduits for the building.

2. A beamless building framework as claimed in claim 1, in which each grid unit spans a bay, and in which any two abutting grid units are secured together by a rod of one of the grids of one unit in longitudinal contact with a rod of the corresponding grid of the other unit, and by rods of the other grids of the two units abutting end to end, the columns having centre lines substantially coplanar with the longitudinally contacting rods and having structure of the columns to which rods of said other grids are secured.

3. A beamless building framework having rectangular bays comprising vertical columns at the corners of the bays, and an all metal open-lattice load-supporting beamless structure spanning the bays and secured to and supported solely by the columns at the corners of the bays, said structure comprising a plurality of all metal similar rectangular grid units that abut and are secured together along their edges, each grid unit comprising an upper grid and a lower grid generally parallel to the upper grid and spaced therefrom, each grid comprising a first set of parallel rods and a second set of parallel rods, the rods of the first sets being parallel to the same side of a bay, the rods of the second set of each grid crossing over the rods of the first set at right angles and being connected to the rods of the first set at the crossings, the distances between adjacent crossings being short compared to the lengths of individual rods of both the first and second sets and compared to the distances between any of the columns at the corners of the bays, and a plurality of sinuous rods running in the same direction between the grids and holding the grids in their spaced apart relationship, each sinuous rod lying in a plane that is inclined relative to the grids and that is parallel to the rods of of one of the sets, each sinuous rod consisting of a wave-like series of alternate peaks and dips connected by straight lengths of the rod, the sinuous rods at the dips being connected to the rods of the lower grid at the crossings of the lower grid, the sinuous rods at the peaks being connected to the rods of the upper grid at the crossings of the upper grid, peaks and dips of adjacent sinuous rods being connected to common crossings of the upper and lower grid respectively, said structure being capable of distributing loads in at least the directions of the rods of both the first and second sets and providing, within bays and from bay to bay, space between the upper and lower grids for passage of ducts and conduits for the building.

4. A beamless building framework as claimed in claim 3, in which the upper and lower grids lie in parallel horizontal planes.

5. A beamless building framework as claimed in claim 4, in which at least one of the columns is hollow whereby conduits may be run up the interior of the column and into said space between the upper and lower grids.

6. A beamless building framework as claimed in claim 4, in which alternate sinuous rods lie in parallel planes and intermediate sinuous rods lie in parallel planes that are inclined relative to the planes of said alternate rods, the planes of all the sinuous rods making equal angles with the horizontal planes of the upper and lower grids.

7. A beamless building framework as claimed in claim 6, in which each grid unit spans a single bay, the grid units being secured together along lines joining the columns.

References Cited in the file of this patent

UNITED STATES PATENTS

1,008,587	Conzelman	Nov. 14, 1911
1,613,788	Dawson et al.	Jan. 11, 1927
1,864,773	Stanford	June 28, 1932
1,906,634	Leake	May 2, 1933
1,911,018	Goeltz	May 23, 1933
1,982,343	Kane	Nov. 27, 1934
2,084,648	MacMillan	June 22, 1937
2,216,732	Brown	Oct. 8, 1940
2,257,762	Paves	Oct. 7, 1941
2,284,898	Hartman	June 2, 1942
2,565,292	Arthur	Aug. 21, 1951
2,616,529	Macdonald	Nov. 4, 1952
2,675,895	Loewenstein	Apr. 20, 1954

OTHER REFERENCES

Publication Architectural Forum, July 1949, of which page 76 only is relied on.