July 12, 1932. J. H. YOUNG 1,867,433

BUILDING CONSTRUCTION

Filed April 30, 1932 4 Sheets-Sheet 1

Fig. 1.

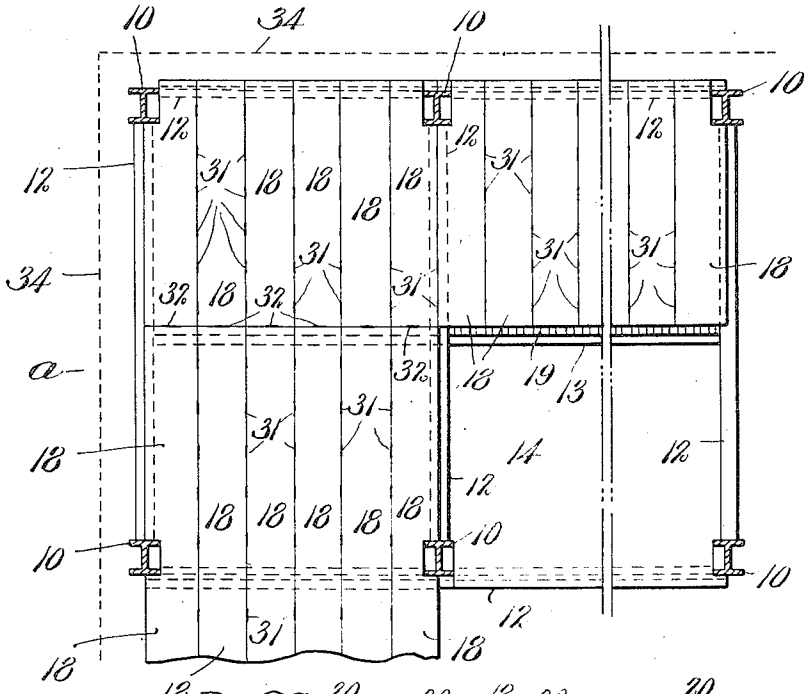
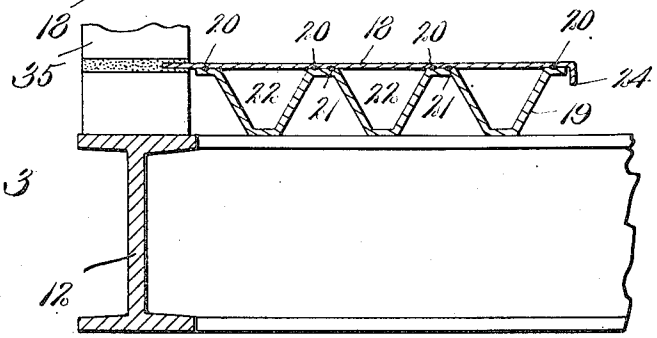


Fig. 3



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July 12, 1932. J. H. YOUNG 1,867,433

BUILDING CONSTRUCTION

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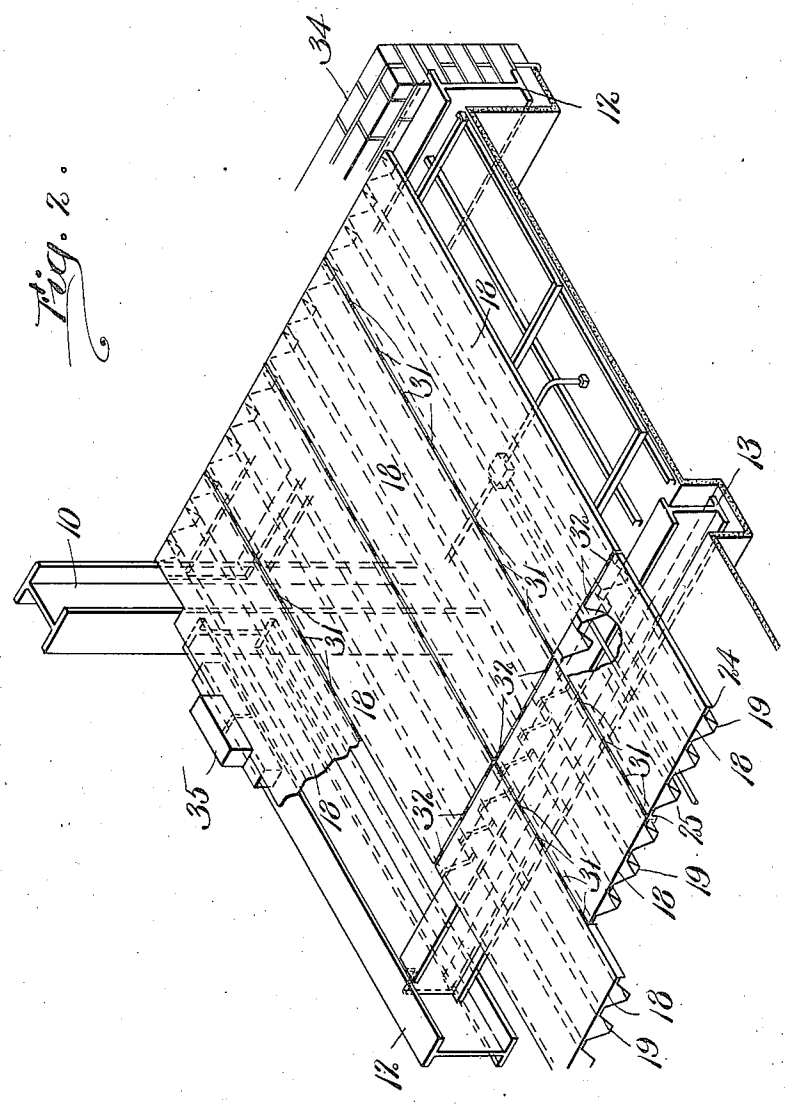
Fig. 2.



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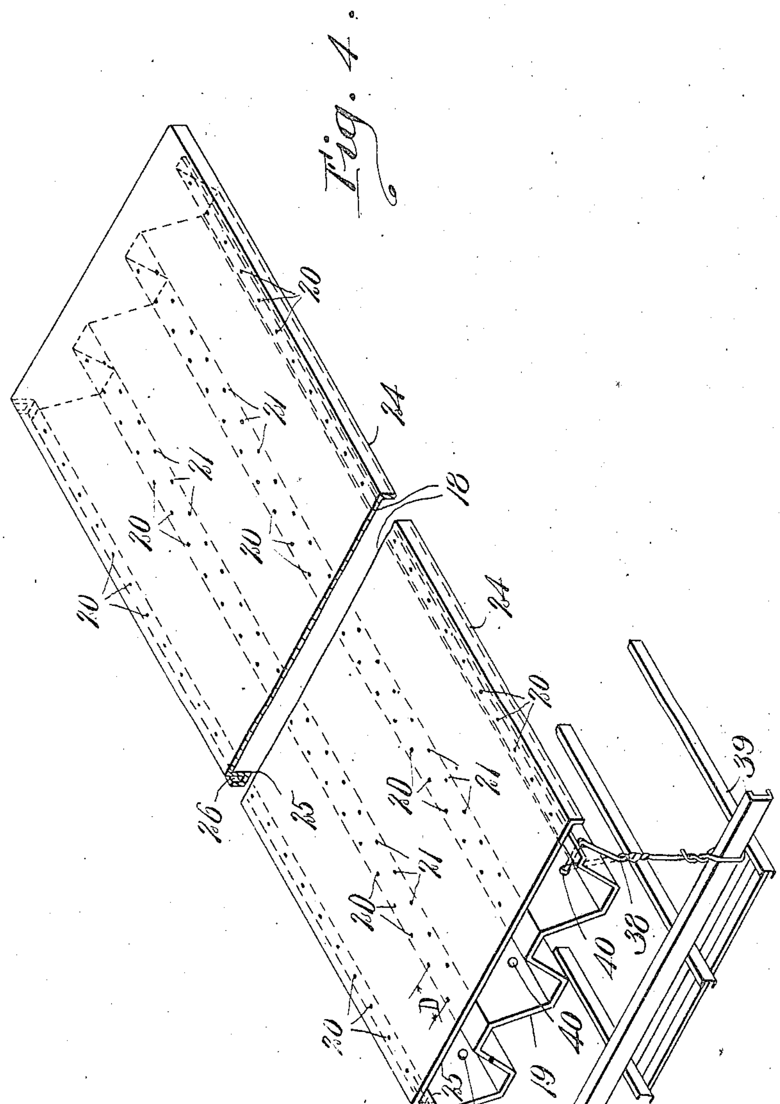
July 12, 1932. J. H. YOUNG 1,867,433

BUILDING CONSTRUCTION

Filed April 30, 1932 4 Sheets-Sheet 3



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July 12, 1932. J. H. YOUNG 1,867,433

BUILDING CONSTRUCTION

Filed April 30, 1932 4 Sheets-Sheet 4

Fig. 5.

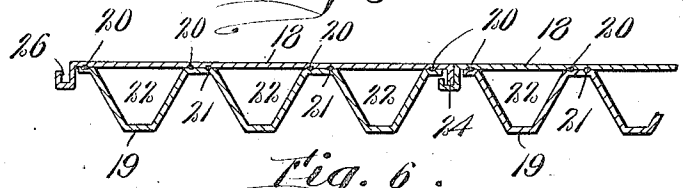


Fig. 6.

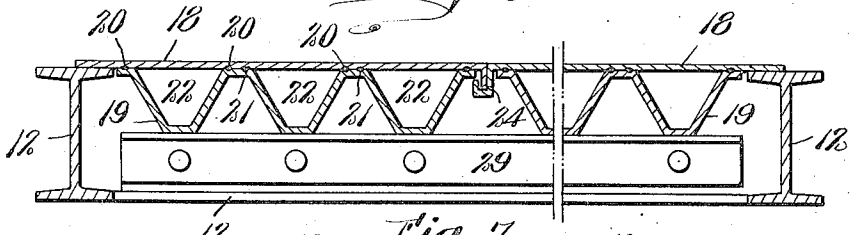


Fig. 7.

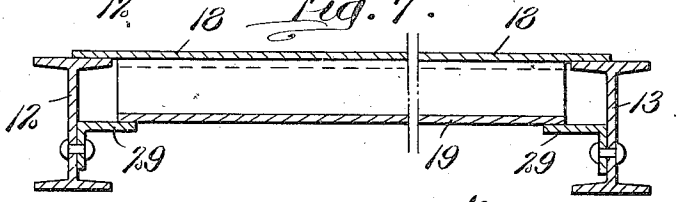


Fig. 8.

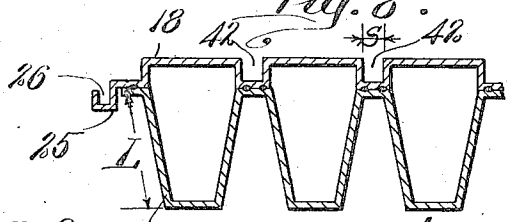


Fig. 9.

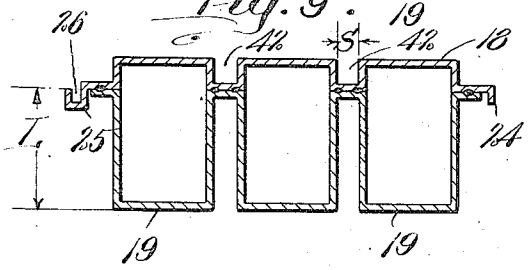
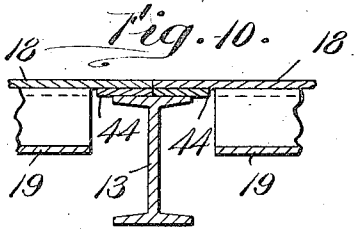


Fig. 10.



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Patented July 12, 1932 1,867,433

UNITED STATES PATENT OFFICE

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BUILDING CONSTRUCTION

Application filed April 30, 1932. Serial No. 608,437.

This invention relates to a building construction and to a flooring for buildings.

This application constitutes a continuation in part of my application Serial No. 524,813, filed March 24, 1931.

The invention has for one of its objects to reduce the cost of a building of the character of a steel frame building, a bridge, or other building structure, and to enable it to be erected in a minimum time while complying with the requirements of the building authorities.

Another object of the invention is to provide a novel cellular metal flooring characterized by its lightness and strength and which is particularly useful in the economical constructions of buildings of the character above mentioned.

A still further object of the invention is to produce a novel cellular metal floor in a building characterized by lightness and strength which may be economically erected and which lends itself particularly to use in providing for the distribution of electric wiring with maximum flexibility.

With these objects in view and such others as may hereinafter appear, the invention consists in the building construction and in the flooring and flooring unit hereinafter described and particularly defined in the claims at the end of this specification.

Fig. 1 is a plan view of a portion of one floor of a building embodying this invention;

Fig. 2, a perspective of a portion of the floor shown in Fig. 1 on an enlarged scale;

Fig. 3, a detail on an enlarged scale, showing an outside sheet metal unit extended over a side metal member of a floor panel;

Fig. 4, a perspective of an intermediate floor unit broken away and illustrating one method of suspending the metal frame for a ceiling;

Fig. 5, a detail in cross section to illustrate the interlocking of the upper sheet metal members of adjacent units;

Figs. 6 and 7, details showing a modified way of supporting the floor unit;

Figs. 8 and 9, details of modified forms of sheet metal units, and

Fig. 10, a detail illustrating a further modified form of floor unit and method of supporting the same.

The present invention contemplates a novel metal floor which is characterized particularly by its lightness and remarkable strength and by the fact that it is capable of production within such limits of cost as to render its use commercially possible in the construction of the floors of office buildings, bridges, and other modern structures. Accordingly, the invention contemplates a cellular metal floor having a plurality of hollow cells, preferably closed in cross section and the walls of which form load-supporting beams capable of sustaining floor loads when the flooring is placed upon standard floor spans. It is preferred to construct a floor embodying the present invention by assembling a plurality of prefabricated units, each unit having a plurality of hollow cells, preferably closed in cross section and the walls of which form the load-supporting beams above referred to, and the units are preferably assembled side by side and end to end to form the floor. The hollow cells may and preferably will be unobstructed to impart maximum potential electrical flexibility to the erected floor.

In producing either the present floor or the present prefabricated flooring unit, I have found that the desired lightness, the necessary strength to sustain required floor loads when the flooring is placed upon standard floor spans together with the economy in metal necessary to enable the floor to be produced and used commercially, may be obtained by correlating the size of the hollow cells forming the load-supporting beams with relation to the thickness of the walls thereof and to the spacing between the cells, and I have found it to be necessary that these factors be so related that the floor and/or the floor unit have a section modulus of at least 1.0 inches^3 per foot width. As far as I am aware, the section modulus of any of the various corrugated sheet metal roofing units heretofore proposed is only a small fraction of the minimum value which I regard as necessary for the production of a practical and commercial cellular metal floor.

In practice I may prefer to produce the present floor and/or floor unit by welding together two component sheet metal members at least one of which is provided with corrugations whereby to form a plurality of hollow beams, and in practice I have found it to be desirable that sheet metal of a thickness of at least 18 gauge be used, and in order to develop the desired strength in the hollow beams thus formed I have found it desirable to weld the component members along the sides and immediately adjacent to the hollow beams either by a continuous weld or by intermittent welds placed so that the maximum spacing between welds bears a definite relation to the thickness of the metal.

As above stated, the drawings illustrate a portion of a building such as an office building or other steel framed structure in which the framework is arranged to form panels or openings at the different floors of the building, and the present metal flooring is erected upon said framework and arranged to cover said panels.

Referring now to the drawings, *a* represents a building, such, for instance, as an office building, which is provided with a steel framework consisting of steel upright members or columns 10 and horizontal steel members usually girders 12 and beams 13. The girders 12 and beams 13 form panels or openings at each floor of the building, and for convenience and simplification only four complete panels 14 of a floor in the building are shown in Fig. 1, one of the panels being uncovered.

In Fig. 1, the longitudinal girders 12 form the side members of the panels 14, and the cross girders 12 and the intermediate beams 13 connecting the longitudinal girders 12 form the end members of the panels 14. Each panel 14 has co-operating with it a sheet metal flooring, which is composed of a plurality of units capable of being fabricated in the shop, transported to the job and laid in place. Each floor unit comprises a sheet metal upper member 18 and a corrugated sheet metal under member 19, which is spot welded or otherwise secured to the underside of the upper sheet metal member 18. The welds are represented in Figs. 3, 5, and 6 at 20, 21. The under sheet metal member 19 is preferably provided with substantially V-beam corrugations which may be of varying depths according to the floor load to be carried, and the upper sheet metal member 18 is preferably made to present a substantially flat upper surface and co-operates with the upper corrugations to close the same and provide the floor unit with substantially closed air spaces 22.

The sheet metal members 18, 19 of the units are made substantially long and of a length substantially equal to the length of the panel, and preferably of such length as to permit the corrugated under member 19 to rest upon and be supported by the metal end members of the panel, and the sheet metal upper member 18 co-operates with the corrugated sheet metal under member 19 to form a floor unit or section of sufficient strength and load-carrying capacity to enable the panels to be made of material length and thereby diminish the number of cross beams or metal members 13 employed in the floors of the building, thereby effecting a material saving in the amount of metal in the framework and in the cost of erecting the same.

The upper and lower members 18, 19 may be made of substantially the same length and arranged with relation to each other and welded in fixed relation, so that one end of the upper member 18 projects beyond the corrugated under member 19 to leave the opposite end of the under member 19 uncovered by the upper member 18 (see Figs. 1, 2 and 4), whereby the corrugated under member 19 of the floor units of adjacent panels may abut on the common end member 13 of said panels and have the upper member 18 of adjacent floor units project beyond said common end member.

The panels 14 are of such a width as to require the use of a plurality of sheet metal floor units, and these floor units may be designated the outside and intermediate units. The intermediate units when laid in the panel are preferably constructed to mechanically interlock with one another and with the outside units. To this end, the upper member 18 of the intermediate unit is provided on one side with a straight depending flange 24 and on its opposite side with a depending flange 25 having a channel 26 into which the straight flange 24 of an adjacent unit is extended, after the manner represented in Figs. 1 and 5.

The outside floor units are provided on their inner side with the appropriate flange, either straight or channeled, to enable the outside units to interlock with the flanges of the adjacent intermediate units.

The floor units may be supported by the lower corrugated members 19 resting on the end metal members of the panels after the manner represented in Figs. 1, 2 and 3, in which case the upper member 18 of the outside units may extend over the side members of the panels and be separated therefrom, or if desired the sheet metal units may be supported by the framework with the corrugated under sheet 19 located within the panels as represented in Figs. 6, 7 and 10.

In Figs. 6 and 7, the floor units are supported by angle pieces 29 secured to the metal framework within the panel and upon which the corrugated under members 19 rest, or said floor units may be located within the panel and be supported by the end members of the panel upon which rest the ends of the upper members 18 of said units, which ends

may be provided with a suitable reinforcement 44 when required as represented in Fig. 10.

When the floor units are required to carry heavy loads it is preferred to have the corrugated under member 19 rest upon the framework.

The sheet metal units when laid in place are designed to have their sides in contact or in close proximity to one another and when thus positioned the upper metal sheets of contiguous units may be spot welded together, as represented by the heavy black lines 31 in Figs. 1 and 2, so as to provide the panel with a sheet metal flooring having a unitary upper sheet metal member of substantially the area of the panel, and having attached to its under side a plurality of groups of independent or separate corrugated sheet metal load-supporting members which extend lengthwise of the panel for substantially the length thereof substantially parallel with one another, each of said groups forming part of an individual unit and being secured to the sheet metal member thereof.

It will be observed that the welding of the upper sheet metal members 18 of the floor units in a panel may be effected by a workman standing on the sheet metal floor.

In the preferred construction illustrated in Fig. 1, wherein the ends of the upper sheet metal members of the floor units of adjacent panels project beyond the common end member 13 of said panels in line with each other, said projecting ends may be spot welded to the ends of the upper sheet metal members of the covered panel, as indicated by the heavy black lines 32 in Fig. 2, and in this manner a plurality of panels are provided with a sheet metal flooring having a unitary sheete metal upper member which extends the length of the plurality of panels in line with each other, and has secured to it a plurality of corrugated load-supporting sheet metal members 19 for each of the said panels.

The outside walls 34 of the building as well as the interior partitions 35 may be of any usual or suitable construction.

From the above description, it will be observed that a steel frame building may be erected at a minmium cost and in a minimum time, because the sheet metal floor units may be made in the shop of a length equal to the length of the panel formed by the steel framework, and of a strength sufficient to support the required or desired load, which strength may be varied to meet different load conditions by using substantially V-beam supporting members of the proper gauge of metal and depth of corrugation, which units may be transported to the job and laid in position, so that each panel may be provided with a sheet metal floor of substantially the area of the panel and composed of sections which are initially mechanically interlocked to hold them in place so as to permit the sheet metal floor to support workmen and apparatus if desired, and which may be permanently connected together by welding the sheet metal upper members together, by workmen supported by the upper members of the floor.

It will also be observed that the flooring units may, as illustrated in the drawings, be mounted upon the panel in a manner such that the corrugations of aligning units cooperate to form continuous substantially unobstructed conduits from one part of the building to the other, which enables the floor to possess maximum potential electrical flexibility. The multiplicity of conduits thus formed affords maximum flexibility in wiring for any kind of electric service, and enables electrical apparatus to be positioned most advantageously and the connections to be made thereto in a most simple, economical and practical manner.

Furthermore, the upper sheet metal members of panels in line with each other may be welded together so as to provide a unitary sheet metal floor which covers a plurality of bays and may extend the length of the building and which is provided with a plurality of separate corrugated sheet metal load-supporting members for each panel.

It will also be observed that is each panel is provided with its sheet metal flooring, wires or other suspending members 38 for the ceiling frame 39 may be attached to the corrugated sheet metal members of said flooring before the sheet metal flooring of the adjacent panel is laid, so that the sheet metal flooring may be completed and provision made for supporting the ceiling underneath in a continuous manner.

The suspending wires 38 may be attached to the uncovered portions of the corrugated lower member 19, by providing the latter with holes 40 in the side walls of the corrugations through which the wires 38 may be passed.

The upper metal member 18 of each floor unit may be provided with an unbroken flat upper surface as shown in Figs. 1 to 7 inclusive, or it may be provided with substantially narrow depressions 42 and yet have its upper surface substantially flat to support the workmen, as shown in Figs. 8 and 9.

In practice, in the construction of modern buildings and particularly modern steel-framed buildings such as office buildings and the like, the floor spans encountered vary from six to twenty-two feet. The floor loads usually encountered in such building construction vary from 70 pounds per square foot up to 700 pounds per square foot. As previously stated I have found that in order to enable the present flooring to be utilized as a commercial floor the size of the hollow cells forming the load-supporting beams, the thickness of the walls thereof, and

the spacing between the cells should be correlated to impart to the floor structure a section modulus of at least 1.0 inches^3 per foot width. The section modulus is to be figured on individual cells as beams, the cells to be construed as including one half the web member on either side of same. The section modulus figure for one foot width of floor is arrived at by multiplying the section modulus of a single cell by the number of cells per foot width of floor. In practice I have found that the spacing indicated in Figs. 8 and 9 as the dimension S between adjacent beams should be less than substantially twice and preferably less than the depth of the beams.

I have also found that the minimum thickness of the sheet steel with which it is practicable to produce the present flooring should be that corresponding to 18 U. S. standard gauge for sheet and plate iron and steel and which is 0.05 inch.

I have found that the length of the side walls of the deepest corrugations in either of the upper or lower metal members 18, 19 forming the present flooring unit, and which is indicated in the drawings in Figs. 8 and 9 as the dimension L, should be less than eighty times the thickness of the metal forming the side walls of said corrugations. As used throughout the claims hereof, the expression "the length of the side walls of the cells" refers to the dimension L illustrated in Figs. 8 and 9 of the drawings.

In order to develop the maximum strength in the flooring unit when the latter is composed of an upper sheet 18 and a lower sheet 19 welded together, it is desirable that the parts be welded together either by a continuous weld, or if welded intermittently as by spot welding as illustrated in Fig. 4, I have found that it is desirable that the distance D between the welds should be less than 70 times the thickness of the sheet steel being welded. For example, if 18 gauge sheet steel is used, then the distance D between the welds should be less than 70 times 0.05 or 3.5 inches. If the distance between welds exceeds this relation, then a tendency exists for the structure to buckle between the welds when subjected to floor loads.

As illustrative of the unusual load-carrying capacity of a floor embodying the present invention and of the remarkable strength compared to its weight, the following data is furnished for a commercial form of the present flooring unit, and in which the individual cells are shaped as illustrated in Fig. 8, in which the width of the unit is 24 inches and is made up of four cells connected together to form the unit, in which the cells are arranged on six inch centers and are of a total cell depth of five and three-quarters inches, being spaced apart by web members one and seven-eighths inches in width and in which the depth of the corrugation of the lower member is four and eleven-thirty-seconds inches, and in which both members of the unit are made of 16 gauge sheet steel. The cells are symmetrically arranged with respect to the side edges of the unit. Such a floor unit has a section modulus greater than 1.0 inches^3 per foot width of unit and which from experimental data has been determined to be 3.06 inches^3 per foot width of unit.

Weight in pounds per square foot..... 9.50

Span in feet	Allowable total loads per square foot of floor, in pounds
6	735
7	540
8	415
9	326
10	265
11	219
12	184

The term "section modulus" as used herein is intended to refer to the lesser section modulus of the flooring in either tension or compression.

By the use of the term "structurally closed in cross section" as employed in the claims I intend to define a cell which has the functional characteristics of an integral cell.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is:

1. The combination with a frame work provided with beams and arranged to form floor panels, of a metal flooring covering said panels, said flooring comprising a plurality of prefabricated units, each unit having a plurality of hollow cells structurally closed in cross section and forming cooperating load supporting beams and with a plurality of said units arranged end to end with a plurality of said hollow cells in alignment and extending over a supporting beam and adapted to form substantially continuous unobstructed ducts.

2. A portable prefabricated flooring unit adapted to be laid side by side and end to end over a floor supporting beam and cooperating with other units to form the flooring, said unit comprising an upper and a lower corrugated sheet having corrugations extending substantially the length of said sheets and secured together with the lower corrugations of the upper sheet opposed to and forming extensions of the upper corrugations of the lower sheet, the corrugations of said units being adapted to form substantially unobstructed aligned ducts extending over said beams, and said ducts being structurally closed in cross section.

3. A portable prefabricated flooring unit comprising a multi-cellular metallic flooring unit, having a plurality of hollow cells, structurally closed in cross section and spaced apart a distance not over twice the depth of the cells, and forming cooperating hollow beams capable of resisting within themselves all of the normal load stresses to which the floor is subjected, the depth of said cells being at least three inches, the width, depth, lateral spacing, and thickness of the walls of said beams being correlated to impart to the structure a section modulus of at least 1.0 inches^3 per foot width.

4. A metal flooring for a building comprising a multi-cellular metallic flooring having a plurality of hollow cells structurally closed in cross section, the depth of said cells being at least three inches and forming cooperating hollow load supporting beams capable of resisting within themselves all of the normal load stresses to which the floor is subjected, the metal comprising the cellular flooring being at least as heavy as 18 gauge sheet steel and said hollow beams being spaced from one another a distance not exceeding the depth of the beams.

5. The combination with a framework provided with beams and arranged to form floor panels of a metal flooring covering said panels, said flooring comprising a plurality of prefabricated units, each unit having a plurality of hollow cells structurally closed in cross section and being at least three inches in depth and forming cooperating load supporting beams and with a plurality of said units arranged end to end and side by side, and said units being connected together at their sides by welding, whereby concentrated loads are distributed over wide areas of the floor, the metal comprising the cellular flooring being at least as heavy as 18 gauge sheet steel and the length of the side walls of the cells being less than 80 times the thickness thereof, and the structure having a section modulus of at least 1.0 inches^3 per foot width.

6. A weight bearing floor unit comprising a series of parallel hollow beams structurally closed in cross section and composed of sheet metal of at least 18 gauge, connected by horizontal webs, each beam being not less than three inches nor more than ten inches in depth, the webs being in width less than the depth of said beams.

7. A metal flooring for a building comprising a multi-cellular metallic flooring having a plurality of cells structurally closed in cross section and forming cooperating hollow load supporting beams, each beam being not less than three inches nor more than ten inches in depth, said beams being capable of resisting within themselves all of the normal load stresses to which the floor is subjected and being spaced apart not over twice the depth of the cells, the width, depth, lateral spacing and thickness of the walls of said beams being correlated to impart to the structure a section modulus of at least 1.0 inches^3 per foot width.

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

JAMES HOWARD YOUNG.