May 8, 1956 A. M. BUTTS 2,744,590

LOAD-SUPPORTING STRUCTURES

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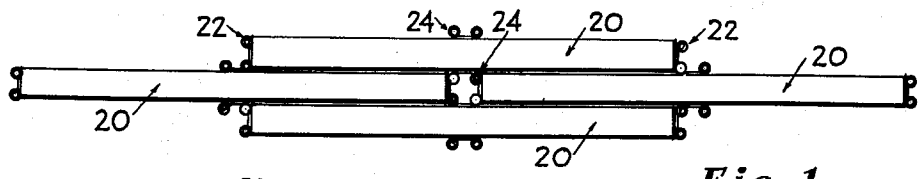

Fig. 1.

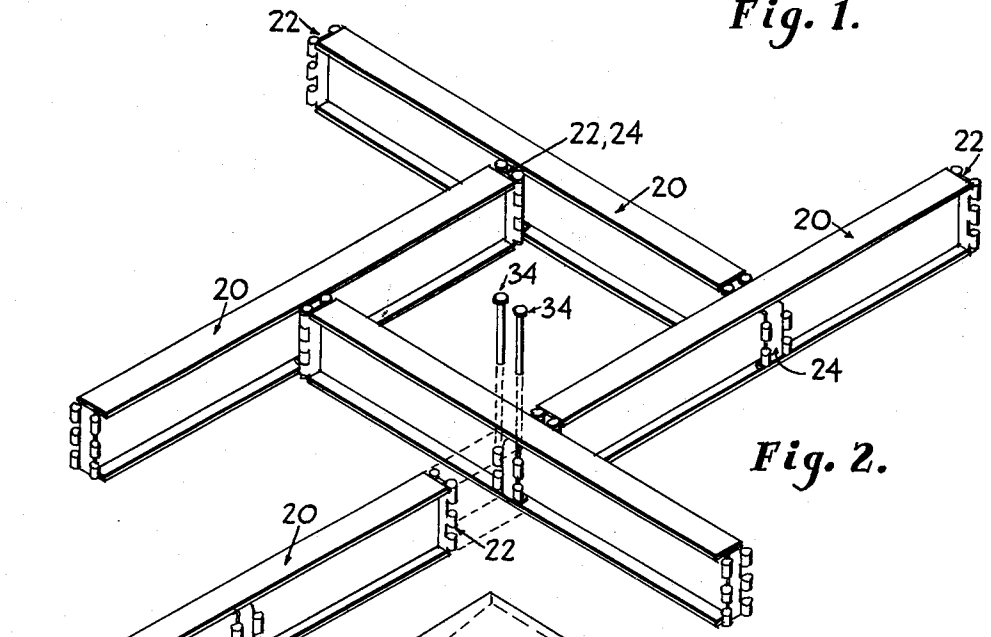

Fig. 2.

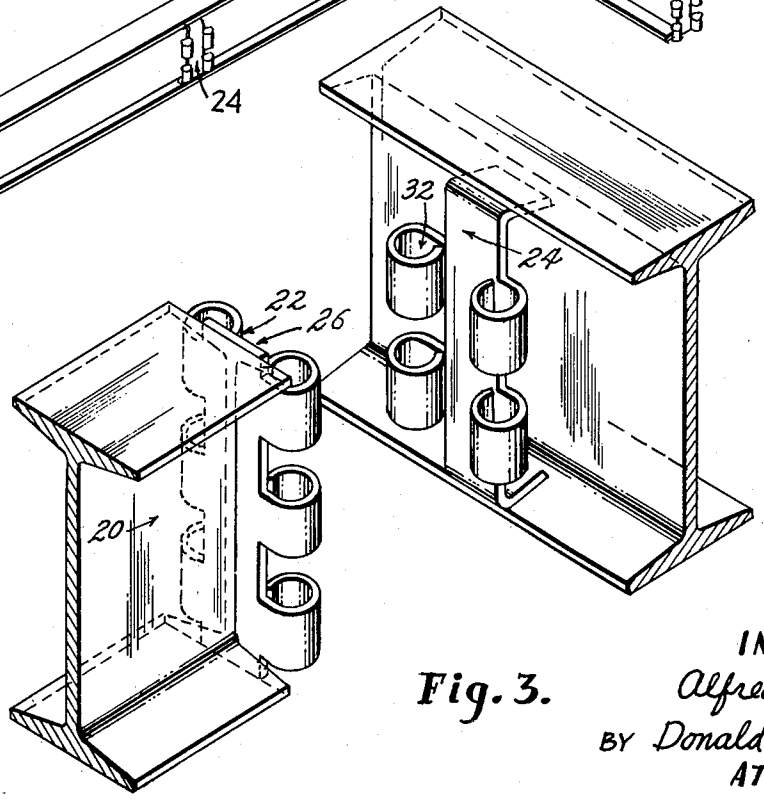

Fig. 3.

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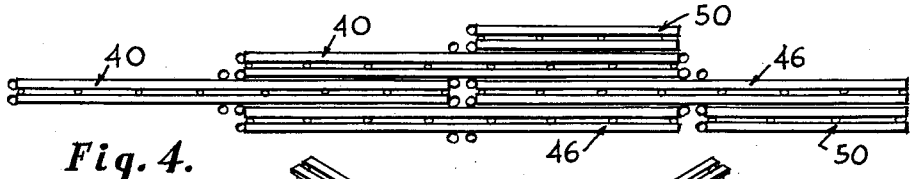

Fig. 4.

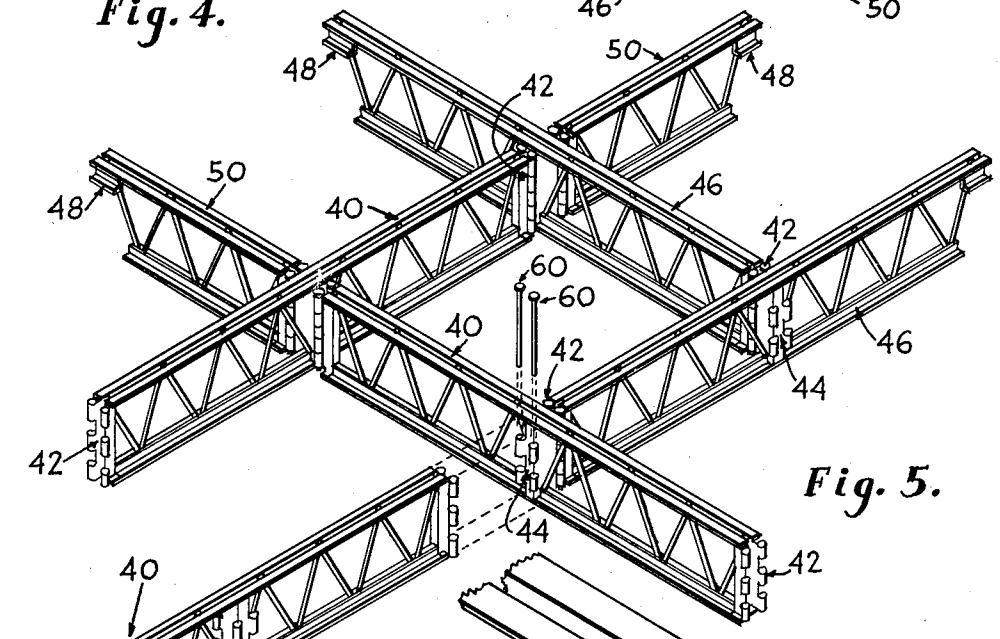

Fig. 5.

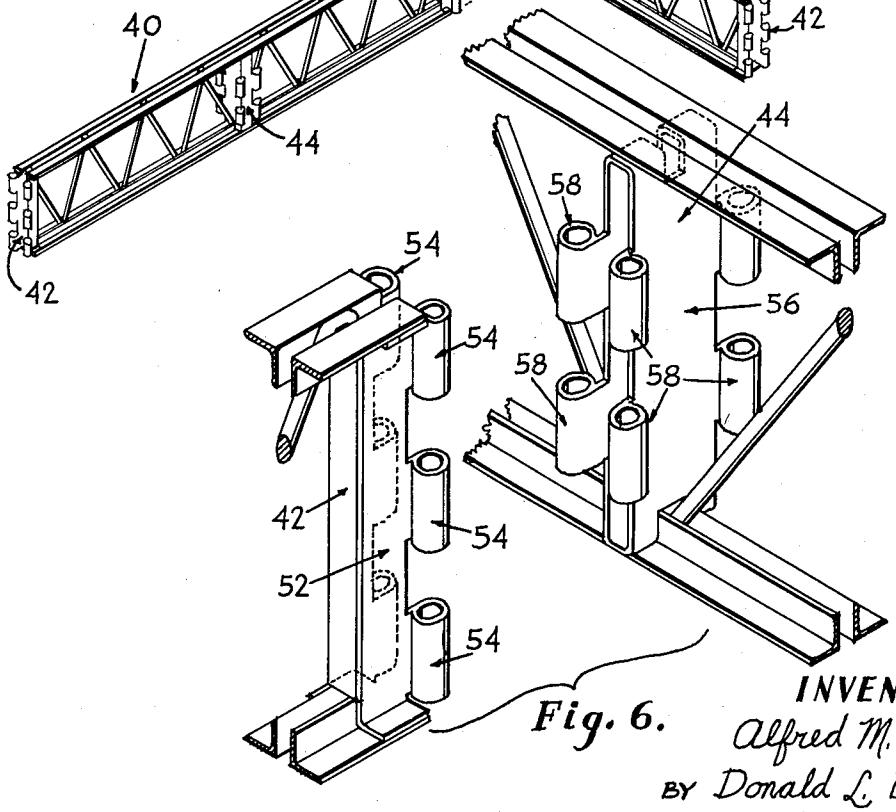

Fig. 6.

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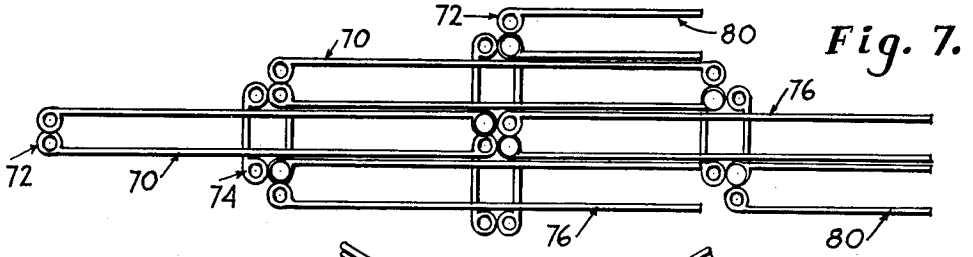

Fig. 7.

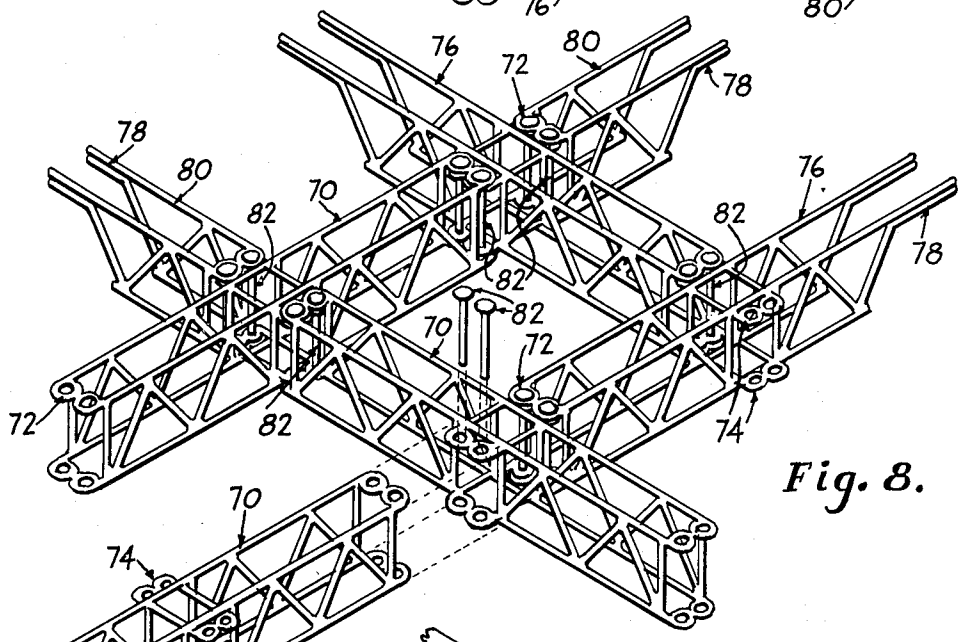

Fig. 8.

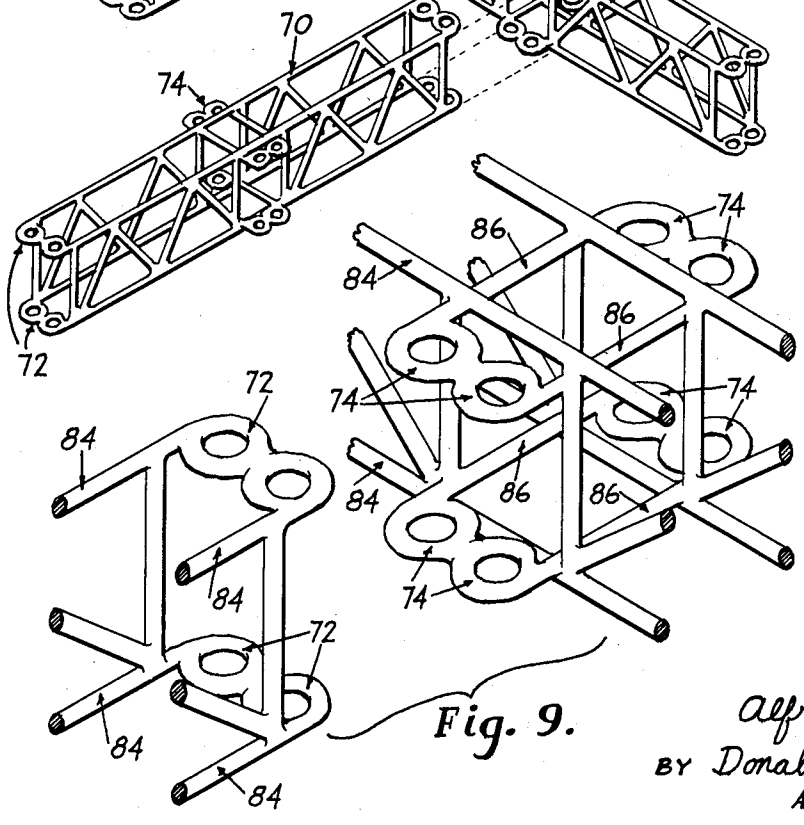

Fig. 9.

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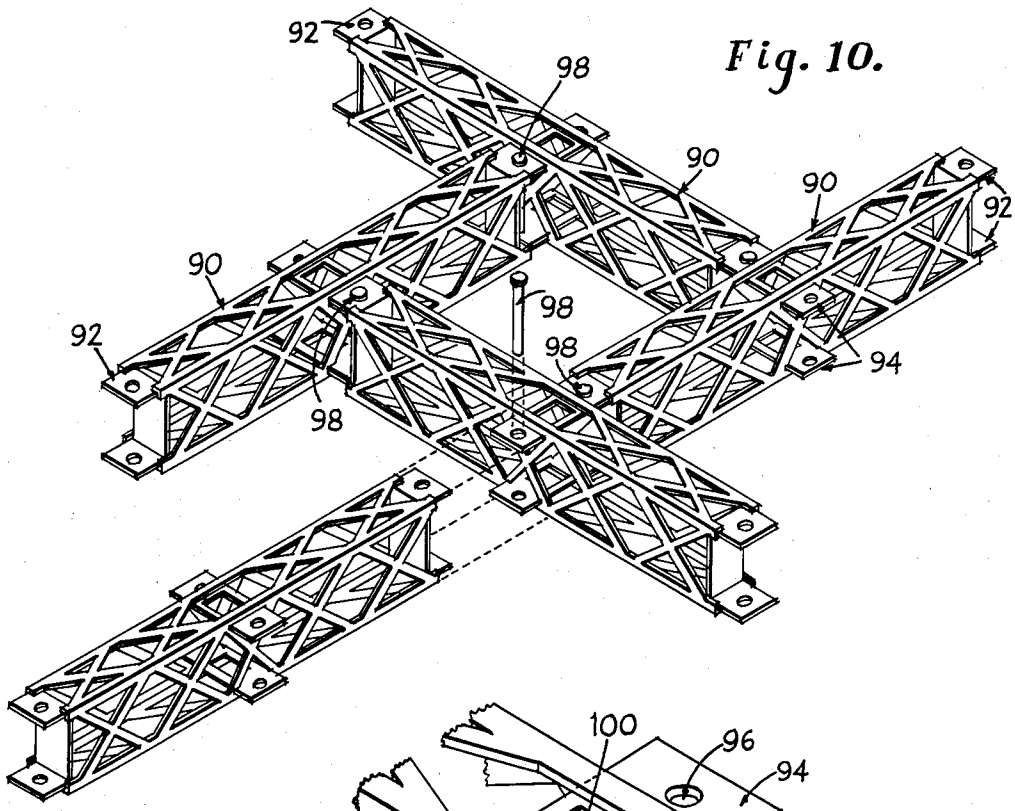

Fig. 10.

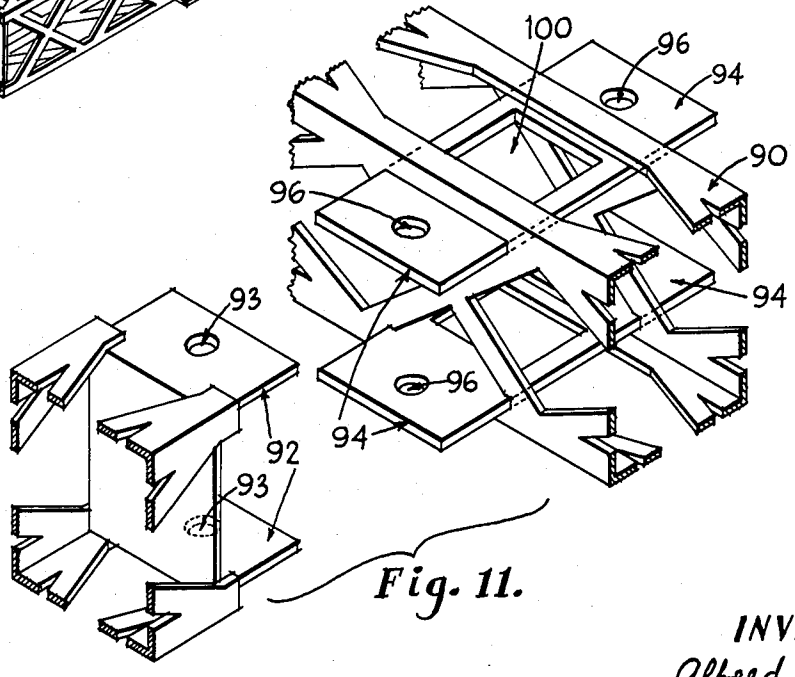

Fig. 11.

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LOAD-SUPPORTING STRUCTURES

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Application December 12, 1950, Serial No. 200,363

6 Claims. (Cl. 189—36)

This invention relates to load-supporting structures and more particularly to structures comprising, as elements, truss units of generally standard construction, capable of prefabrication, which can be simply assembled to form a generally criss-cross pattern or grid for spanning almost any predetermined area to provide a support, for example, for a floor or a roof of a building.

In my copending application Serial No. 615,741, (now Patent No. 2,534,852) filed September 12, 1945, for Structural Units of Gridlike Construction Providing Supports for Walls, Floors or the Like, there are disclosed load-supporting structural units formed of a plurality of structurally strong elements of substantially uniform construction which are secured together by connector members appreciably shorter in length than said elements and mounted intermediate the ends of said elements. Said elements are adapted to be so interconnected by said members as to produce an arrangement capable of spanning any predetermined area, the elements at the periphery of said arrangement being in some instances smaller in size than the other elements so that the grid can have the ends of all of the elements along one edge thereof lie in a straight line and can be supported, for example, on a rectangular foundation or other floor or ceiling support without projecting beyond the sides of the rectangle. Generally speaking, however, the essential repetitive pattern of the grid is formed by at least four full length structural elements and at least four connector members, these being arranged to give a pattern whose center is a closed four-sided figure having its sides of equal length and formed by a portion of the length of each of the four elements. A connector member is located at each corner of the four-sided figures and a portion of each element extends for a substantial part of its length as a projection of a side of the four-sided figure. One end of each of the connector members and of the elements is thus available for further connection with other elements and connector members to continue this structural pattern and to produce a grid that can cover substantially any desired area.

One object of the present invention is to provide a load-supporting grid embodying essentially the same basic repetitive pattern as the grid structures of said copending application but which has its structural elements, and especially the means for interconnecting said elements, of novel construction.

A further object is to provide an improved grid structure of the type which is especially adapted to give a quicker assembly of parts and also possesses a greater regidity when assembled and which, in some respects, is also easier to manufacture and provides a more efficient structure for using light-weight structural elements.

It is a further object of the present invention to provide an improved load-supporting structure of the foregoing type which can be readily collapsed into a compact unit and which, without the need of any additional connecting members, can be locked in its collapsed condition.

These and other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises an article of manufacture possessing the features, properties and the relation of elements which will be exemplified in the article hereinafter described and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description, taken in connection with the accompanying drawings, wherein:

Figure 1 is a top plan view of one embodiment of a portion of a load-supporting grid comprehended by the present invention, said grid consisting of only four structural elements and being shown in its collapsed position;

Fig. 2 is a perspective view of the structure of Fig. 1 in expanded position, showing the construction of the elements constituting the assemblage and the construction of the means for connecting together said elements, a fifth element being shown in exploded relation to the four elements of Fig. 1 to illustrate the method of assembly of said units;

Fig. 3 is an enlarged perspective view, with parts broken away, of the end and intermediate connecting portions of the structures of Fig. 1 and 2, these parts being shown in exploded view for the purpose of clarity;

Fig. 4 is a top plan view of another modification of a structural grid comprehended by the present invention embodying, in addition to the four full length structural elements for giving the basic repetitive pattern, a pair of additional elements substantially half the length of the other elements;

Fig. 5 is a perspective view, with parts thereof exploded, showing the structure of Fig. 4 in expanded position and illustrating the structural modifications of the ends of certain of the components of the structure which adapt the structure for being mounted on one corner of a rectangular supporting foundation.

Fig. 6 is a view, similar to Fig. 3, of the connecting means of the structure of Fig. 5;

Figs. 7, 8 and 9 are figures similar to Figs. 4, 5 and 6, respectively, illustrating another modification of the load-supporting structure in collapsed and expanded position; and

Fig. 10 and 11 are figures generally like Figs. 2 and 3, respectively, and illustrate a further modification of the structure of the invention which is not as well suited as the others for being collapsed but which can be even more readily assembled at the side of use.

Referring now to Figs. 1 to 3, inclusive, there is illustrated, by way of example, a portion only of one form of the novel structural grids comprehended by the present invention, it being understood that the structures of Figs. 1 and 2, which comprise four and five members, respectively, can be added to, in a manner which will become more fully apparent hereinafter, to form a unit of substantially any desired area. As shown, the structural unit comprises a plurality of structurally strong elements **20** which, in the illustrated embodiment, have the general shape of I beams, each said element having rigidly secured thereto, as for example by being integrally formed therewith or welded thereto, a suitable end connector member **22** and also having rigidly secured thereto, intermediate its ends and on opposite sides thereof, a pair of intermediate connector members **24**.

Each end connector member **22** (Fig. 3) preferably comprises a central supporting plate **26**, lateral extensions of which are formed into a plurality of spaced annular elements **28** which form two pin-receiving sockets, said sockets being laterally spaced so as to be substantially opposite the end corners of the I beam and being

substantially parallel to the depth of the I beam. The intermediate connector members **24** also comprise a plate-like supporting plate **30** which, in the illustrated embodiment, is rigidly secured at its opposite ends to the inner face of the flanges of the I beam, as by being welded thereto. Lateral extensions of plate **30** are also formed into a pair of pin-receiving sockets and each said socket comprises a pair of axially spaced annular elements **32** which are adapted to cooperate with the similar, spaced, annular elements of the end connector members **22** to provide two substantially continuous composite sockets for receiving a pair of pins **34** and thus rigidly securing an end of one of I beams **20** to the intermediate portion of another of I beams **20**.

As shown in the exploded portion of Fig. 2, two pins **34** are positioned for insertion into the composite sockets formed by interlocking the annular socket portions of end connector member **22** with the annular socket portions of the intermediate connector member **24**. Similar connections are effected at each of the corners of the four-sided central figure of the structural pattern shown in Fig. 2.

It is to be noted that by removing one of the two pins at each of the connections between the elements of the assembled grid structure, the remaining pin and the composite socket in which said pin is mounted may serve as a hinge for pivoting the structural elements with respect to one another to collapse the entire grid structure to the shape shown in Fig. 1. It will be observed that when this is accomplished the empty end socket of each element becomes positioned and interlocks with an empty intermediate socket of another element and that by replacing the pins which have been removed into these new composite sockets it becomes possible to lock the structure in its collapsed or folded position. It is to be noted too that the collapsibility of the grid in the above-described manner is greatly facilitated by the use of structural elements **20** which, together with their connector members **22** and **24**, are of the same general shape and size except that at the outer edges of the composite grid there may be provided elements of shorter length and of modified construction to assist in mounting of the complete, assembled structure upon a suitable foundation or wall-supporting framework.

A corner portion of another form of grid structure comprehended by the present invention is shown in Figs. 4 to 6, inclusive, and illustrates the modified type of structural element which may be used at the outer edges of the grid in order to facilitate the mounting of the grid upon a suitable supporting structure, for example of rectangular or square shape. As shown, the main structural elements of the grid are trusslike in shape and, specifically, are open web steel joists.

The portion of the grid structure illustrated in collapsed position in Fig. 4 and in expanded position in Fig. 5 comprises six structural elements of three different shapes, similar elements being shown in pairs. Elements **40** are full length elements with end connector members **42** provided at each end thereof and with intermediate connector members **44** provided intermediate the ends thereof. Elements **46** are also full length members but are provided with end connector members **42** at one end only, the other end of each of said elements **46** being provided with flat portions **48** for facilitating the placement of grid on walls, foundations or other supports.

Two half length members **50** are also provided and these are equipped at one end only with end connector member **42** and at the other end with a flat portion **48** for engaging the grid support.

In Fig. 5 there is shown a third full length element **40** which is adapted to be connected to one of the other elements **40** to continue the grid pattern, the other connector members shown in Fig. 5 being similarly connected to full length structural elements **40** or **46** to continue the pattern. The end connector members **42** and the intermediate connector members **44** are of generally similar construction and are so constituted as to interlock with one another to provide composite annular pin-receiving sockets of the same general construction as the sockets of Figs. 1 to 3 inclusive.

In general, the end connector members **42** (as best shown in Fig. 6) are unitary structures welded or otherwise rigidly secured to the ends of the elements **40**, **46** and **50**, and thereby add to the rigidity and structural strength of the latter elements. In the form shown, said connector members comprise a U-shaped central supporting plate **52**, lateral extensions of which are annularly shaped to form pin-receiving socket elements **54**. The intermediate connector members **44** are of a unitary structure and comprise a central section **56** secured intermediate the outer beams of the open web steel joists and provided on both sides with extensions that are shaped into pin-receiving sockets **58**, which sockets are adapted to fit between the sockets **54** of the end connector members **42** to provide a pair of composite sockets for receiving pins **60** (Fig. 2) whereby the structural elements of the grid can be rigidly secured together in assembled expanded position. Alternatively, upon the removal of one of each pair of said pins **60** at each of the connections, the grid structure can be collapsed to give the arrangement of Fig. 4 and this arrangement can also be locked together by replacing the removed pins in the new composite sockets formed by the interlocking of the open sockets of each pair of end and intermediate sockets.

Referring now to Figs. 7 to 9, inclusive, there is shown still another embodiment of the grid structures of the invention and, as shown, the elements of the grid structure bear the same relationship to one another as do the elements of the grid structure shown in Figs. 4 and 5. The structure comprises the regular full length truss elements **70**, each of which is equipped with end connector members **72** at both ends thereof and intermediate connector members **74** on opposite sides thereof, and full length modified truss elements **76**, which are equipped with intermediate connector members **74** but have only one end connector member **72**, the other end of each said element being provided with a flat portion **78** for resting on a suitable support for the grid. In addition, there are provided half length elements **80** which are equipped at one end only with end connector member **72** and at the other end with flat support-engaging portions **78**. Suitable pins **82** are provided for connecting together said elements.

In this novel embodiment of the invention, the elements are composed of two parallel trusses which are built up of rods, bent to shape and welded together at all the joints. The top and bottom rods **84** (Fig. 9) are curled around at their ends to form complete circles and the connected pairs of the latter constitute end connector members **72**. Two circles are provided at the top and at the bottom of the truss and these circles, in each case, are laterally spaced so that two coaxial pin-receiving sockets are formed at each end of the composite element. Intermediate the ends of each pair of trusses, short rods **86**, curled into circular shapes at their ends, are welded to the top and bottom rods **84** of the truss and also have their circular portions welded together to provide the pairs of pin-receiving sockets that constitute intermediate connector members **74**. The trusses are joined together, as in the previous embodiment, by slipping pins through the connector members, the circular sockets of the intermediate connector members fitting between the circular sockets of the end connector members **72**.

It is to be observed that at the center of each of elements **70** the connection between short rods **86** and top and bottom rods **84** of the truss is such as to leave an open space through which a vertical support, such as a column or post, could pass. It becomes possible, by virtue of this arrangement, to attach each of the pair of trusses, which form the individual element, to opposite sides of a vertical

support extending through this central open space and thereby obtain improved rigidity and a more efficient transfer of the forces from the horizontal load-supporting grid structure to the vertical columns or posts.

A further modification of the grid structure is shown in Figs. 10 and 11, the elements **90** of which are so constructed that they can be very simply assembled and yet will give a very rigid load-supporting arrangement. In the form shown, each of elements **90** is a rectangular or square tube, the sides of which are trusses. At each end of said elements there is provided a connector member **92** in the form of a U-shaped plate, the arms of which are provided with coaxial openings **93** (Fig. 3). Rigidly secured, as by welding or by being integrally formed therewith, to each of elements **90**, intermediate the ends thereof, are a pair of plates **94**, portions of which extend on both sides of said element **90**. Said sidewise extending portions of plates **94** are provided with suitable pin-receiving openings **96** which are coaxial with one another and provide intermediate connector members on opposite sides of each of said elements **90** for coaction with end connector members **92**.

The flat ends of plates **94** and of end connector members **92** so abut portions of elements **90** in their connected position as to provide a very rigid arrangement even though a single pin **98** is employed to connect each end of said elements to the intermediate portions of another element.

Plates **94** of intermediate connector members are also preferably provided with central recesses **100** so that a vertical support, such as a column or post, can also pass through the center of the element and may be secured to plates **94** and to the sides of element **90**. The boxlike or tubular structure of each of elements **90**, which is most effectively obtained by connecting together four trusses, provides an arrangement of great strength for a given weight of material.

It will now be apparent from the foregoing disclosure that many modifications in the form of the elements are possible within the purview of the present invention. It is additionally to be understood that the term "pin" is used herein in a generic sense to include such other connecting members as bolts, rods, bars, etc. The important characteristic of this element of the combination is that it is relatively rigid and can be slidably inserted into the sockets formed therefor by end and intermediate connector members. In the embodiment wherein the gridlike structure is adapted to be collapsed with said connector members and said pins cooperating to form what is in effect a hinge, the pins are circular in transverse cross section, but in embodiments, for example, of the type shown in Figs. 10 and 11, where the structure is not intended to be collapsed, the recesses **96** of the intermediate connector members and the recesses of the end connector members **92** may be of a configuration other than circular, e. g., square, for receiving pins of the same cross-sectional configuration.

Since certain changes may be made in the above article and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A collapsible load-supporting, horizontally extending grid comprising at least four structurally strong beamlike elements, each said element having two load-transmitting connector members rigidly secured thereto intermediate the ends and on opposite sides thereof and having two load-transmitting end connector members rigidly secured to the opposite ends thereof, each said end connector member of one of said elements having a plurality of surfaces in load-transmitting engagement with surfaces of an intermediate connector member of another of said elements to form at least two laterally spaced load-transmitting sockets comprising vertically offset portions of said connector members, said sockets extending depthwise of said elements for receiving two laterally spaced pins for connecting together said elements, the engaged connector members transmitting vertical load directly to one another, each said element having one of the end connector members thereof secured to one of the intermediate connector members of another element by means of two laterally spaced pins to form a structural pattern whose center is a closed four-sided figure and whose sides are of equal length and are formed by a portion of the length of each of four said elements, a connector member being located at each corner of said four-sided figure and having one of the two pins associated therewith positioned at the apex of the angle forming said corner and the other of said two pins positioned exteriorly of said figure, and each of said element extending for a substantial part of its length as a projection of a side of said four-sided figure, one end of each said element being thus available for further connection with other elements of similar construction to continue the foregoing structural pattern and to produce a horizontally extending grid covering substantially any desired area, said elements, when secured together by one pin only at each connection, being capable of pivotal movement about a vertical axis relative to one another whereby removal of only the exteriorly positioned pins from the connector members of two opposite corners of said four-sided figure and removal of only the other of said pins from the connector members of the other two corners of said figure permits the collapse of said elements from said four-sided structural pattern to a compact side-by-side arrangement.

2. A collapsible load-supporting, horizontally extending grid comprising at least four structurally strong beamlike elements, each said element having two load-transmitting connector members rigidly secured thereto intermediate the ends and on opposite sides thereof and having two load-transmitting end connector members rigidly secured to the opposite ends thereof, each said end connector member of one of said elements having a plurality of surfaces in load-transmitting engagement with surfaces of an intermediate connector member of another of said elements to form at least two laterally spaced load-transmitting sockets comprising vertically offset portions of said connector members, said sockets extending depthwise of said elements for receiving two laterally spaced pins for connecting together said elements, the engaged connector members transmitting vertical load directly to one another, each said element having one of the end connector members thereof secured to one of the intermediate connector members of another element by means of two laterally spaced pins to form a structural pattern whose center is a closed four-sided figure and whose sides are of equal length and are formed by a portion of the length of each of four said elements, a connector member being located at each corner of said four-sided figure and having one of the two pins associated therewith positioned at the apex of the angle forming said corner and the other of said two pins positioned exteriorly of said figure, and each said element extending for a substantial part of its length as a projection of a side of said four-sided figure, one end of each said element being thus available for further connection with other elements of similar construction to continue the foregoing structural pattern and to produce a horizontally extending grid covering substantially any desired area, said elements, when secured together by one pin only at each connection, being capable of pivotal movement about a vertical axis relative to one another whereby removal of only the exteriorly positioned pins from the connector members of two opposite corners

of said four-sided figure and removal of only the other of said pins from the connector members of the other two corners of said figure permits the collapse of said elements from said four-sided structural pattern to a compact side-by-side arrangement, said elements having the socket portions of the end and intermediate connector members from which said pins have been removed so positioned that when said elements are collapsed said socket portions provide pin-receiving means for locking the structure in its collapsed position.

3. The load-supporting grid according to claim 1 wherein the structural elements are each composed of a pair of rigidly connected parallel trusses.

4. The load-supporting grid according to claim 3 wherein each said truss is built up of welded rods and top and bottom rods thereof are curled to form pin-receiving sockets.

5. The load-supporting grid according to claim 4 wherein short rods are welded to the top and bottom rods and curled to provide the intermediate connector members.

6. The load-supporting grid according to claim 1 wherein each structurally strong element is generally tubular in shape and has a central recess between the intermediate connector members capable of receiving a vertical support.

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