Aug. 22, 1967 R. A. G. CAPE 3,336,718

SPACE DECKS

Filed June 15, 1964 2 Sheets-Sheet 1

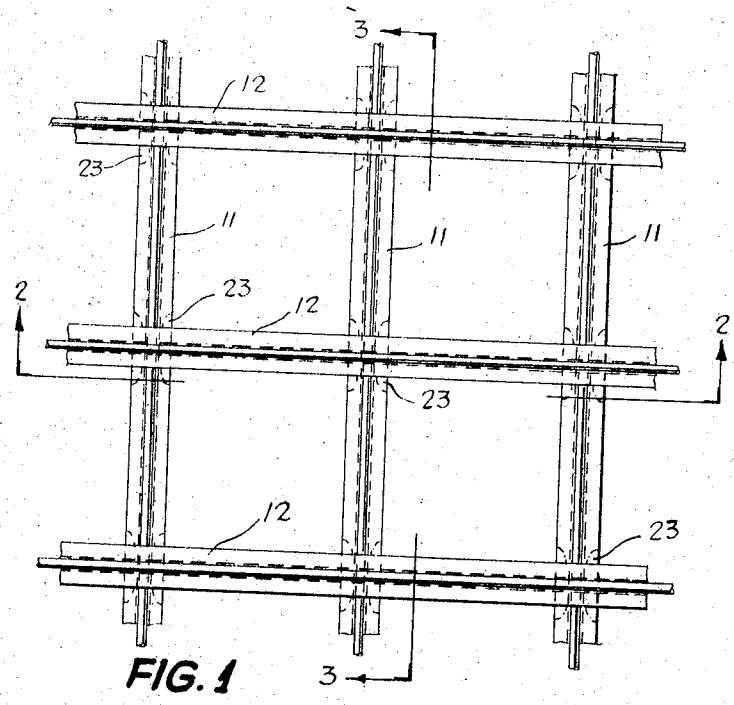


FIG. 1

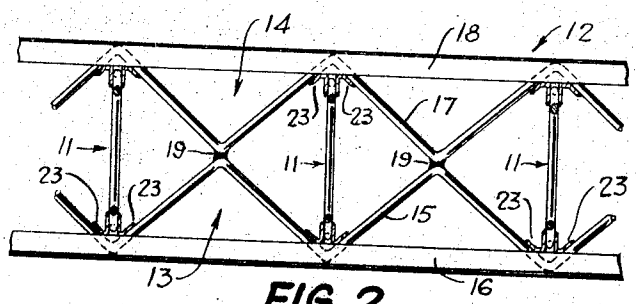


FIG. 2

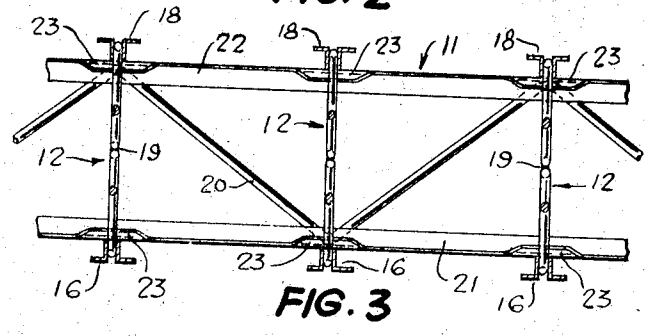


FIG. 3

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SPACE DECKS

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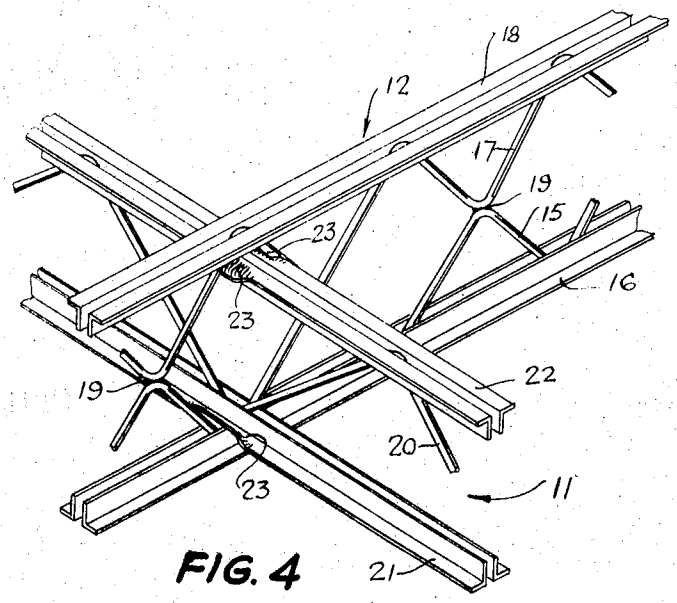


FIG. 4

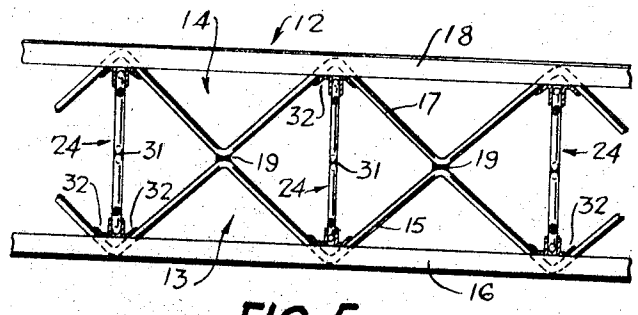


FIG. 5

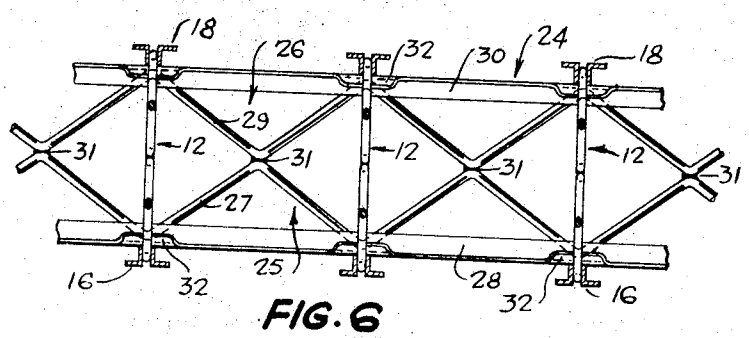


FIG. 6

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United States Patent Office 3,336,718 Patented Aug. 22, 1967

3,336,718

SPACE DECKS

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Filed June 15, 1964, Ser. No. 374,986
9 Claims. (Cl. 52—650)

This invention relates to an improved method for the fabrication of grid-type space decks as used in the construction of roof and floor members in buildings and like structures.

Grid-type space decks are grids or lattices of structural members and are essentially constant depth horizontal space frames which carry loads in a two-directional manner, similar to flat plates. Thus, concentrated loads are distributed over large areas of the structure, achieving a substantially uniform stress distribution.

The usual application of space decks is to carry roof or floor loads where they are supported at regular intervals by columns, or continuously supported around a boundary by a bearing wall, beams or other line support.

Grid-type space decks are usually constructed by assembling a large number of individual bars into a lattice structure, or by assembling two systems of mass produced open-web double chord steel joists to intersect each other at right angles, or oblique angles, and thereby form a lattice structure.

One proposal for assembling the two systems of open-web steel joists involves assembling regular joists in the main direction and threading shallower cross joists, at right angles or oblique angles to the regular joists, through the openings in the regular joists, to form the lattice structure.

This proposed assembly procedure is very difficult to execute and is also relatively expensive due to the number of man hours required for threading the cross joists through the main joists.

Another disadvantage is that when the prefabricated joists are of the type having a continuous bent and undulating bar for the joist web, the maximum depth of the joists is limited by the maximum depth of undulations which the bar bending and jig equipment can produce. This limitation sometimes leads to the inability to produce joists of sufficient depth for economical design.

The present invention overcomes the disadvantages outlined for the proposed space deck assembly procedures by providing open-web joists, or trusses, of a depth approximately equal to one half of the required space deck depth, having continuous undulating web bars and having only one chord.

The single chord joists are assembled in pairs to form upper and lower halves of the main joists, with shallower cross joists positioned between the chords of the upper and lower halves to form the lattice structure.

The preferred method of assembling the space deck is firstly to position the lower halves of the main joists in parallel alignment and with the open-webs extending upwardly from the lower chords, then to position the cross joists over the lower halves to form the lattice structure and then to position the upper halves over the lower halves with the open webs extending downwardly from the upper chords and contacting the open webs of the lower halves. The assembly is then welded together to form a rigid structure.

The disadvantages previously mentioned for the proposed space deck assemblies are, therefore, overcome in the present invention by eliminating the procedure of threading the cross joists through the main joists and by permitting space decks of greater depth to be produced without any changes to the existing joist manufacturing

equipment. This greater depth results from the production of the main joists in two halves and means that space deck depth can now be increased until the shallower cross joists are equal to the maximum depth joists obtainable with the existing manufacturing equipment.

As an alternative execution of the present invention the depth of the space deck can be increased still further by manufacturing the cross joists as upper and lower halves, in a manner similar to the manufacture of the main joists.

It is, therefore, the main object of the present invention to provide an improved method for the fabrication of grid-type space decks which eliminates the threading of cross joists through main joists to form the lattice structure.

Another object of the present invention is to provide an improved method for the fabrication of grid-type space decks, wherein space decks of increased depths are obtainable without changing any of the existing joist manufacturing equipment.

A further object of the present invention is to provide an improved space deck wherein prefabricated open-web joists are used to form a lattice structure and wherein the main joists are prefabricated as upper and lower halves to provide reduced assembly time and consequent improved economies, when compared with proposed methods of space deck production and assembly.

These and other objects and advantages of the present invention will be further apparent by reference to the following detailed specification and figures in which:

FIG. 1 is a plan elevation of a portion of a space deck embodying the features of the present invention.

FIG. 2 is a section on 2—2 in FIG. 1 and shows details of the two-part main joists.

FIG. 3 is a section on 3—3 in FIG. 1 and shows details of the shallower cross joists.

FIG. 4 is a perspective view of a cross joist intersecting a two-part main joist.

FIG. 5 is a section, similar to FIG. 2, but showing an alternative execution of the present invention in which the cross joists are also manufactured in two halves.

FIG. 6 is a section, similar to FIG. 3, but showing further details of the alternative execution shown in FIG. 5.

With reference now to the figures in which like numerals represent like parts throughout the several views, FIG. 1 shows a plan elevation of a portion of a space deck in which cross joists **11** intersect main joists **12** to form a lattice structure.

In FIG. 2, which is a section on 2—2 in FIG. 1, main joists **12** are shown as comprising lower single chord joists **13** and upper single chord joists **14**. Each of the lower single chord joists **13** are composed of a continuous undulating web bar **15** welded to a lower chord **16**, and each of the upper single chord joists **14** are composed of a continuous undulating web bar **17** welded to an upper chord **18**. The undulating web bars **15** and **17** are positioned relative to one another to form a series of diamond shapes and are welded together where they contact, at **19**, to form the main joists **12**. Cross joists **11** are positioned between lower and upper chords **16** and **18**, respectively, at the points where the diamond shapes, formed by web bars **15** and **17**, are widest.

In the execution shown in FIG. 2, cross joists **11** are spaced between each of the diamonds formed by web bars **15** and **17**, but it will be understood that, dependent upon the required strength of the space deck, cross joists **11** can be positioned through each alternate diamond, or other spacing, as required.

In FIG. 3, which is a section on 3—3 in FIG. 1, cross joists **11** are shown positioned between lower and upper chords **16** and **18**, respectively, of main joists **12**.

Cross joists **11** each comprise a continuous undulating web bar **20** with lower chords **21** and upper chords **22** welded to the lower and upper edges thereof. Lower and upper chords **21** and **22**, respectively, are welded to web bars **15** and **17** where they intersect and are deformed at **23**, local to the intersection points, to fit snugly between the angles formed by web bars **15** and **17**.

Lower and upper chords **16**, **21** and **18**, **22**, respectively, are shown in this execution as each comprising two angle members welded to each side of their respective web bars, but it will be understood that other shapes of chord could equally well be used, depending on the required strength of the joist, such as single flat strips welded to the upper and lower edges of the web bars.

FIG. 4 is a perspective view of one cross joist **11** intersecting one main joist **12**.

FIGS. 5 and 6, which are sections similar to FIGS. 2 and 3, respectively, show an alternative execution of the present invention. In this alternative execution increased space deck depth is obtained without any change of existing manufacturing equipment, by fabricating cross joists **11** in two halves, in a manner similar to the fabrication of main joists **12**. Thus the maximum space deck depth will now be equal to approximately twice the maximum depth joist obtainable with the existing manufacturing equipment.

In FIG. 5, main joists **12** again comprise lower single chord joists **13** and upper single chord joists **14**, welded together at contact points **19**. Cross joists **24** are positioned to intersect main joists **12** through the widest points of the diamond shapes formed by web bars **15** and **17**. Again, the spacing of cross joists **24** through main joists **12** will depend upon the required strength of the space deck structure.

FIG. 6 shows cross joists **24** positioned between upper and lower chords **16** and **18**, respectively, of main joists **12**. Cross joists **24** comprise lower single chord joists **25** and upper single chord joists **26**. Each lower single chord joist **25** comprises a continuous undulating web bar **27** welded to a lower chord **28** and each upper single chord joist **26** comprises a continuous undulating web bar **29** welded to an upper chord **30**. Web bars **27** and **29** are welded together at contact points **31**, in a similar manner to the welding of main joists **12**.

Lower and upper chords **28** and **30**, respectively, are welded to web bars **15** and **17** where they intersect and are deformed at **32**, local to said intersection points, to fit snugly between the angles formed by web bars **15** and **17**.

Space decks constructed in accordance with the present invention are preferably assembled on the ground, or floor, and then lifted to the final elevation by conventional jacking procedures. Thus the complete assembly procedure for the preferred execution of the present invention would be substantially as follows:

(1) Space deck support columns or other support structures are erected.

(2) Timber supports are then placed on the ground in order to provide a level working area.

(3) The lower single chord main joists are then laid in spaced parallel relation on the timber supports.

(4) The cross joists are then positioned over the main lower single chord joists, in the V's formed by the web bars, thus forming the lattice structure. The assembly is then tack welded together.

(5) The upper single chord main joists are then positioned over the lower single chord main joists with the web bar undulations aligned to form the diamond shapes through which the cross joists are now positioned.

(6) The completed assembly is then rigidly welded together at all contact and intersection points to form a rigid space deck structure.

(7) The tops of the support columns, or other support structures, are then rigged with jacking frames and the space deck is lifted into its final position.

(8) The space deck is then rigidly connected to the support columns.

The method of assembling the alternative execution of the present invention will be similar to the method for assembling the preferred execution, with the exception that lower single chord joists **25** and upper single chord joists **26** will be pre-assembled and welded together to form cross joists **24**, before assembly with main joists **12**.

In another alternative method of assembly the structure is rigidly welded together at each stage of subassembly, instead of being temporarily tack welded together and then rigidly welded at the final assembly.

Under certain conditions it may be desirable to assemble the space deck on the supports at the final raised elevation and this will require a further alternative assembly procedure basically as follows:

(1) The cross joists **11**, or **24**, are assembled in spaced parallel relation on the elevated supports.

(2) Then lower chords **16** and upper chords **18** are assembled transversely across the cross joists to form the lattice structure. Lower and upper chords **16** and **18**, respectively, are positioned such that the V's of opposing web bars substantially form diamond shapes, the cross joists lying between the points of the diamonds, as in the preferred execution.

(3) The complete space deck assembly is rigidly welded together in a manner similar to the preferred execution.

It will be understood that other methods may be adopted for rigidly fastening together the space deck structure, such as bolting, or other suitable means.

It will be further understood that the structural members forming the space decks, according to this invention, may be of steel, aluminum or other suitable structural material.

Although throughout this specification emphasis has been laid on the use of open-web joists as the main structural members, it will be understood that this invention could equally well be adapted to the use of deep trusses, as the main structural members.

It is thus seen that the present invention accomplishes all of the objects and advantages as set forth.

What I claim is:

1. A method for the fabrication of space decks of the grid type having main joists and cross joists mounted in mutually perpendicular planes, used in the construction of buildings and like structures comprising the steps of arranging a plurality of lower single chord open-web main joists in parallel spaced relation and having their open-webs extending upwardly from said lower single chords, the open-webs of said lower single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, then arranging a plurality of cross joists in parallel spaced relation to extend transversely across said lower single chord main joists and therewith form a lattice framework, said cross joists positioned within said lower portions of said lower web bars, then arranging a plurality of upper single chord open-web main joists in parallel spaced relation to extend transversely across said plurality of cross joists and to be vertically aligned over said plurality of lower single chord joists to complete said space deck, said upper single chord main joists having their open-webs extending downwardly from said upper single chords, the open-webs of said upper single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, said upper portions of said upper web bars being positioned over said cross joists in vertical alignment over said lower portions of said lower web bars, and then fastening together said lower and upper single chord main joists and said cross joists to form a rigid structure.

2. The method as set forth in claim 1 in which said lower and upper single chord main joists and said cross joists are fabricated in steel and are fastened together by welding to form said rigid structure.

3. A method for the fabrication of space decks of the grid type having main joists and cross joists mounted in mutually perpendicular planes, as used in the construction of buildings and like structures comprising the steps of arranging a plurality of lower single chord open-web steel main joists in parallel spaced relation and having their open-webs extending upwardly from said lower single chords, the open-webs of said lower single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, then arranging a plurality of steel cross joists in parallel spaced relation to extend transversely across said lower single chord main joists and therewith form a lattice framework, said cross joists positioned within each of said lower portions of said lower web bars, then tack welding together said cross joists to said lower single chord main joists, then arranging a plurality of upper single chord open-web steel main joists in parallel spaced relation to extend transversely across said plurality of cross joists and to be vertically aligned over said plurality of lower single chord joists to complete said space decks, said upper single chord main joists having their open-webs extending downwardly from said upper single chords, the open-webs of said upper single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, said upper portions of said upper web bars being positioned over said cross joists in vertical alignment over said lower portions of said lower web bars, and then rigidly welding together said lower and upper single chord main joists and said cross joists to form a rigid structure.

4. A method for the fabrication of space decks of the grid type having main joists and cross joists mounted in mutually perpendicular planes, as used in the construction of buildings and like structures comprising the steps of preparing a plurality of double chord cross joists by assembling together in vertically aligned pairs a plurality of lower single chord open-web steel cross joists having the open-webs extending upwardly from the lower single chords thereof and a plurality of upper single chord open-web steel cross joists having the open-webs extending downwardly from the upper single chords thereof and contacting the open webs of said lower single chord cross joists and then welding together said assembled pairs at said contact points, then arranging a plurality of lower single chord open-web steel main joists in parallel spaced relation and having their open-webs extending upwardly from said main lower single chords, the open webs of said lower single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, then arranging said plurality of cross joists in parallel spaced relation to extend transversely across said lower single chord main joists and therewith form a lattice framework, said cross joists positioned within said lower portions of said lower chord web bars, then arranging a plurality of upper single chord open-web steel main joists in parallel spaced relation to extend transversely across said plurality of cross joists and to be vertically aligned over said plurality of lower single chord main joists to complete said space deck, said upper single chord main joists having their open-webs extending downwardly from said upper single chords, the open webs of said upper single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, said upper portions of said upper web bars being positioned over said cross joists in vertical alignment over said lower portions of said lower web bars, and then welding together said lower and upper single chord main joists and said cross joists to form a rigid structure.

5. A method for the fabrication of space decks of the grid type having main joists and cross joists mounted in mutually perpendicular planes, used in the construction of buildings and like structures comprising the steps of arranging a plurality of cross joists in parallel spaced relation, then arranging a plurality of upper single chord open-web main joists in parallel spaced relation to extend transversely across said plurality of cross joists to therewith form a lattice framework, the open-webs of said upper single chord main joists extending downwardly from said upper single chords, the open webs of said upper single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, then arranging a plurality of lower single chord open-web main joists in parallel spaced relation to extend transversely below said plurality of cross joists and to be vertically aligned beneath said plurality of upper single chord main joists to complete said space deck, said lower single chord main joists having their open-webs extending upwardly from said lower single chords, the open webs of said lower single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, said upper portions of said upper web bars being positioned over said cross joists in vertical alignment over said lower portions of said lower web bars, said cross joists positioned within said lower portions of said lower chord web bars, and then fastening together said upper and lower single chord main joists and said cross joists to form a rigid structure.

6. A method for the fabrication of space decks of the grid type having main joists and cross joists mounted in mutually perpendicular planes, used in the construction of buildings and like structures comprising the steps of arranging a plurality of cross joists in parallel spaced relation, then arranging a plurality of lower single chord open-web main joists in parallel spaced relation to extend transversely below said plurality of cross joists to therewith form a lattice framework, the open-webs of said lower single chord main joists extending upwardly from said lower single chords, the open webs of said lower single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, said cross joists positioned within said lower portions of said lower chord web bars, then arranging a plurality of upper single open-web main joists in parallel spaced relation to extend transversely across said plurality of cross joists and to be vertically aligned above said plurality of lower single chord main joists to complete said space deck, said upper single chord main joists having their open-webs extending downwardly from said upper single chords, the open webs of said upper single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, said upper portions of said upper web bars being positioned over said cross joists in vertical alignment over said lower portions of said lower web bars, and then fastening together said upper and lower single chord main joists and said cross joists to form a rigid structure.

7. A space deck of the grid type having main joists and cross joists mounted in mutually perpendicular planes, for use in the construction of buildings and like structures comprising a rigid lattice framework, said framework including a plurality of lower single chord open-web main joists arranged in parallel spaced relation and having their open-webs extending upwardly from said lower single chords, the open-webs of said lower single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, a plurality of cross joists arranged in spaced relation and extending transversely across said lower single chord main joists to therewith form said lattice framework, said cross joists positioned within said lower portions of said lower web bars, and a plurality of upper single chord open-web main joists arranged in parallel spaced relation and extending transversely across said plurality of cross joists and vertically aligned over said plurality of lower single chord main joists, the open-webs of said upper single chord

main joists extending downwardly from said upper single chords and comprising continuous undulating web bars forming alternate upper and lower portions, said upper portions of said upper web bars positioned over said lower portions of said lower web bars with said cross joists passing therebetween, said lower and upper single chord main joists and said cross joists being fastened together to form said rigid framework.

8. A space deck as set forth in claim 7 in which said main and cross joists are manufactured in steel and in which said lattice framework is welded together to form a rigid structure.

9. A space deck of the grid type having main joists and cross joists mounted in mutually perpendicular planes, for use in the construction of buildings and like structures comprising a rigid lattice framework, said framework including a plurality of lower single chord open-web steel main joists arranged in parallel spaced relation and having their open-webs extending upwardly from the lower single chords thereof, the open webs of said lower single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, a plurality of double chord cross joists arranged in parallel spaced relation and extending transversely across said lower single chord main joists to therewith form said lattice framework, said double chord cross joists each comprising a lower single chord open-web steel cross joist having its open-web extending upwardly from the lower single chord thereof and an upper single chord open-web steel cross joist having its open-web extending downwardly from the upper single chord thereof and contacting the open web of said lower single chord cross joists, said cross joists positioned within said lower portions of said lower chord web bars, and a plurality of upper single chord open-web steel main joists arranged in parallel spaced relation and extending transversely across said plurality of double chord cross joists and vertically aligned over said plurality of lower single chord main joists, said upper single chord main joists having their open webs extending downwardly from the upper single chords thereof, the open webs of said upper single chord joists comprising continuous undulating web bars forming alternate upper and lower portions, said upper portions of said upper web bars being positioned over said cross joists in vertical alignment over said lower portions of said lower web bars, said main and cross joists being welded together to form said rigid lattice framework.

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