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Nelson et al.

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[54] **HEAVY DUTY SPACE FRAME FOUR-WAY SPACE FRAME**

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[51] **Int. Cl.** **E04c 3/04**

[58] **Field of Search** 52/650, 636, 646, 52/648, 721, 691, 692, 693, 695

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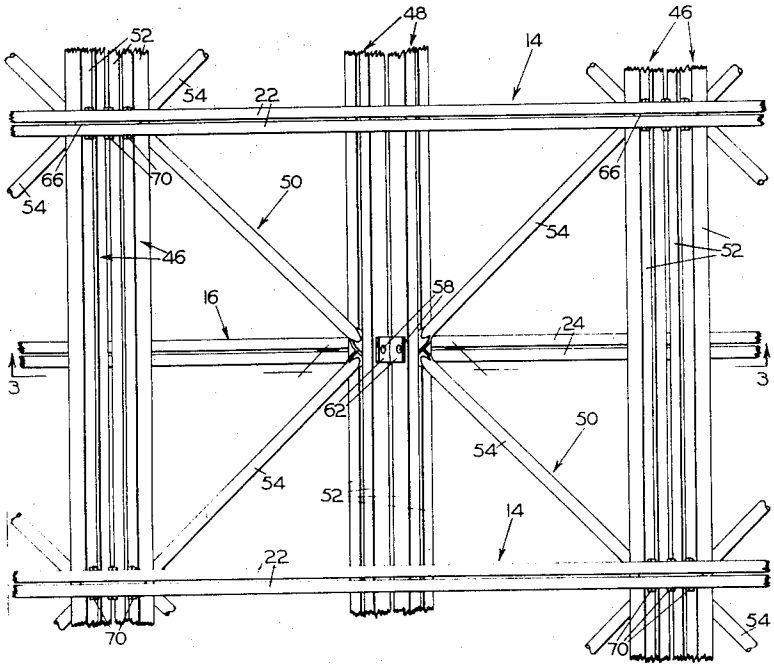
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[57] **ABSTRACT**

A space frame adapted to be supported across a bearing support comprises a plurality of spaced, substantially parallel chords arranged in upper and lower planes. A plurality of joist-type web members are disposed between the chords of the two planes, transversely of the chords. Connecting means interconnect the chords and web members. Support means for the chords and web members support the same separately on the bearing support. The completed assembly thus becomes a two-way joist system whereof the joist-type web members comprise one set of joists and the transversely arranged chords interlocked with the web members comprise the other set.

4 Claims, 8 Drawing Figures



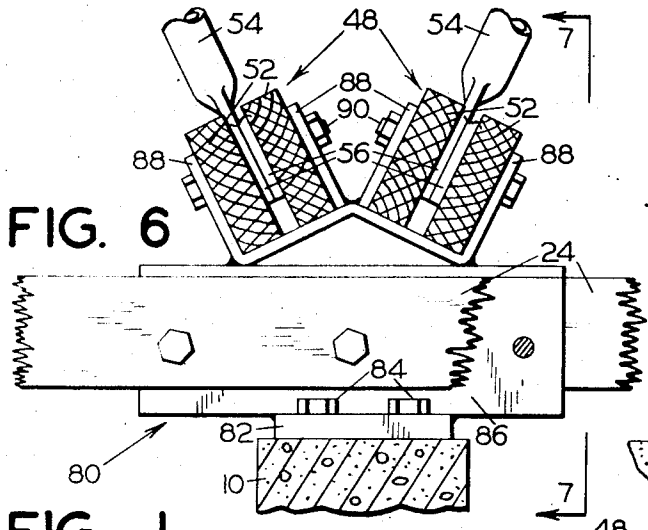


FIG. 6

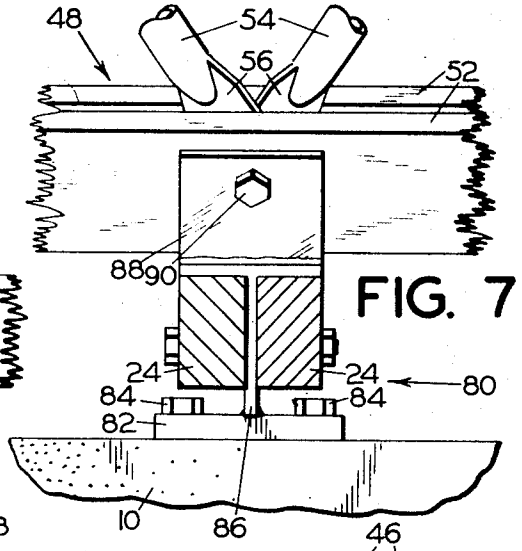


FIG. 7

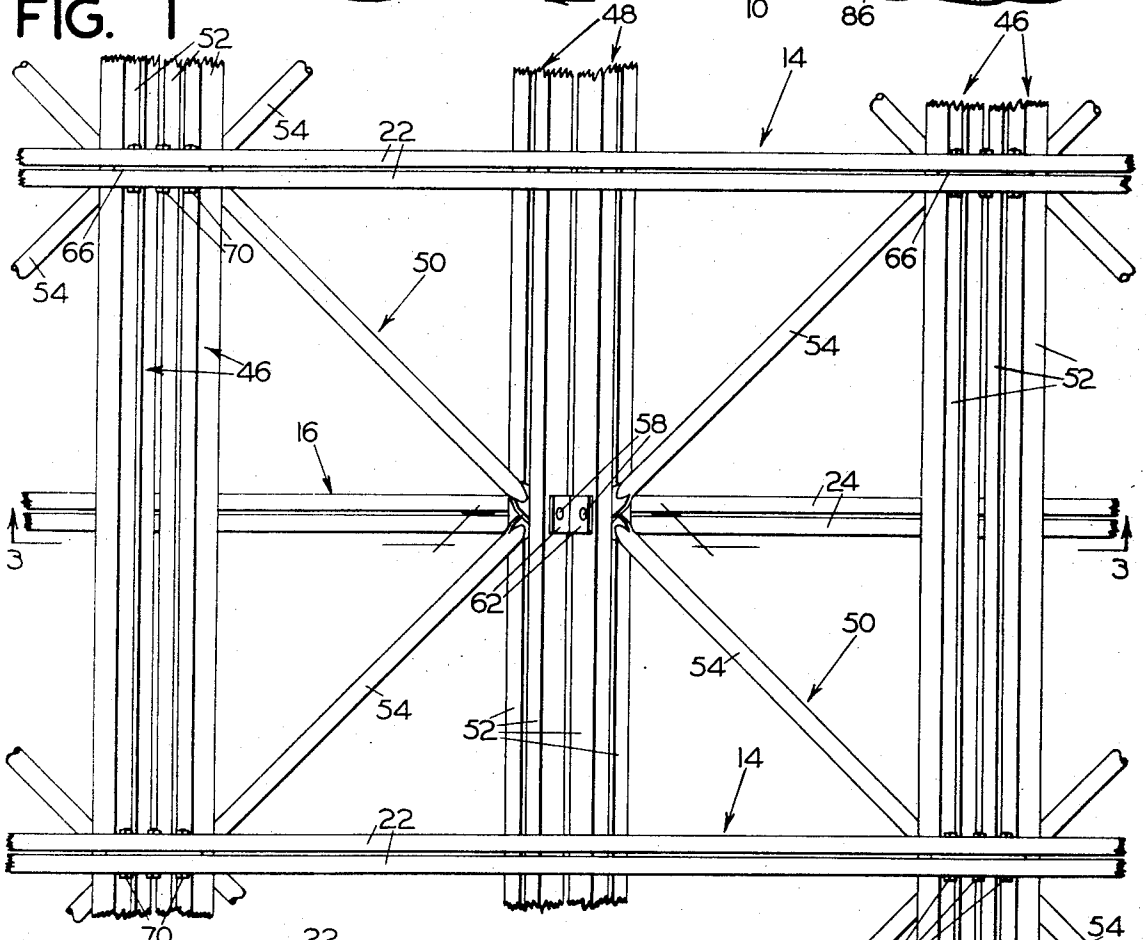


FIG. 1

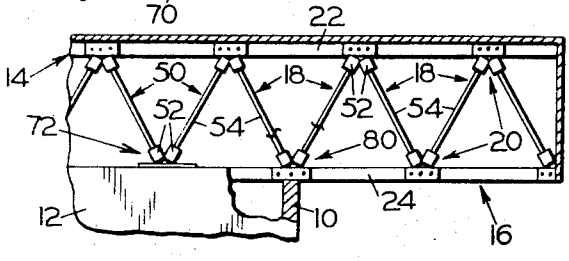
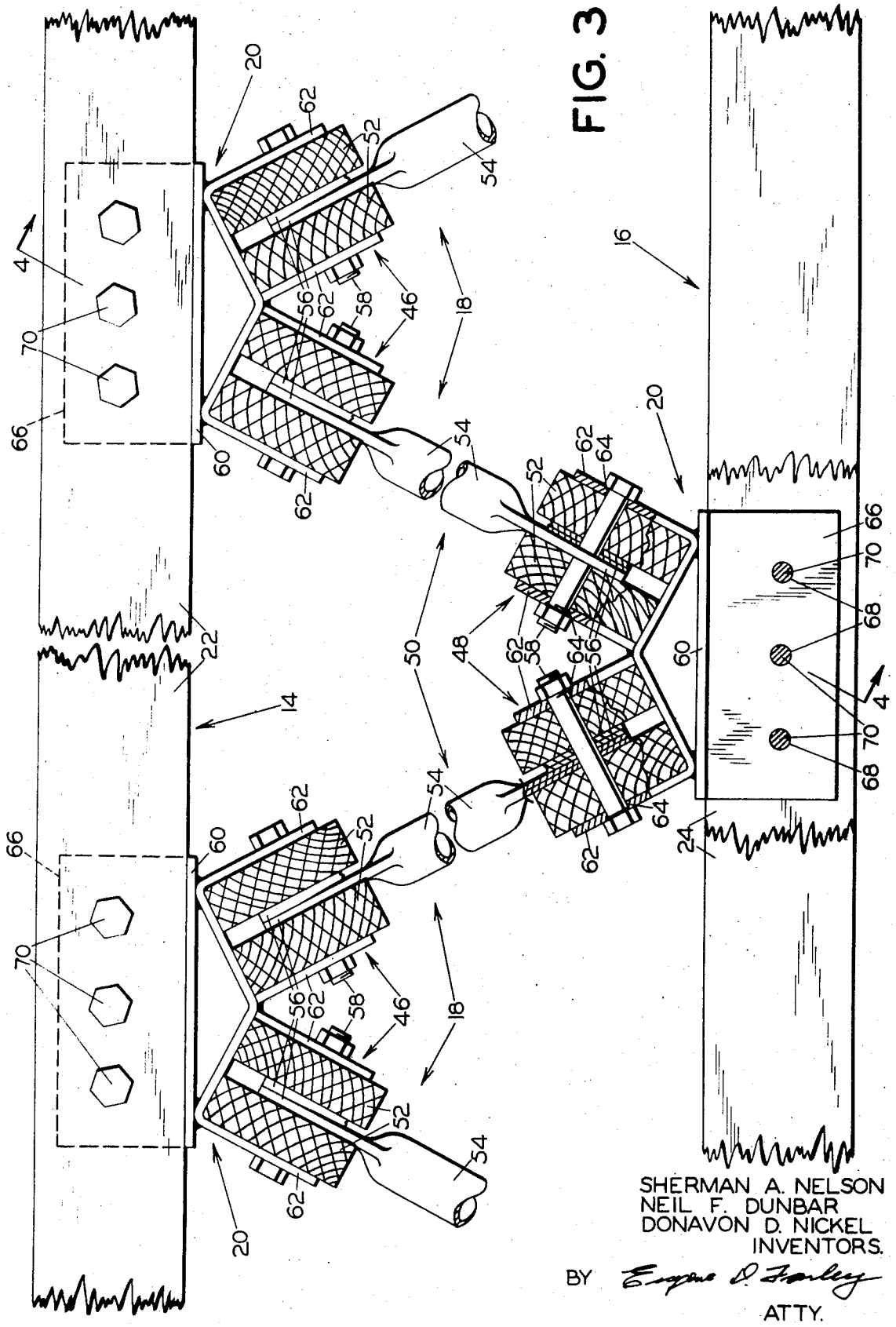


FIG. 2

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FIG. 3



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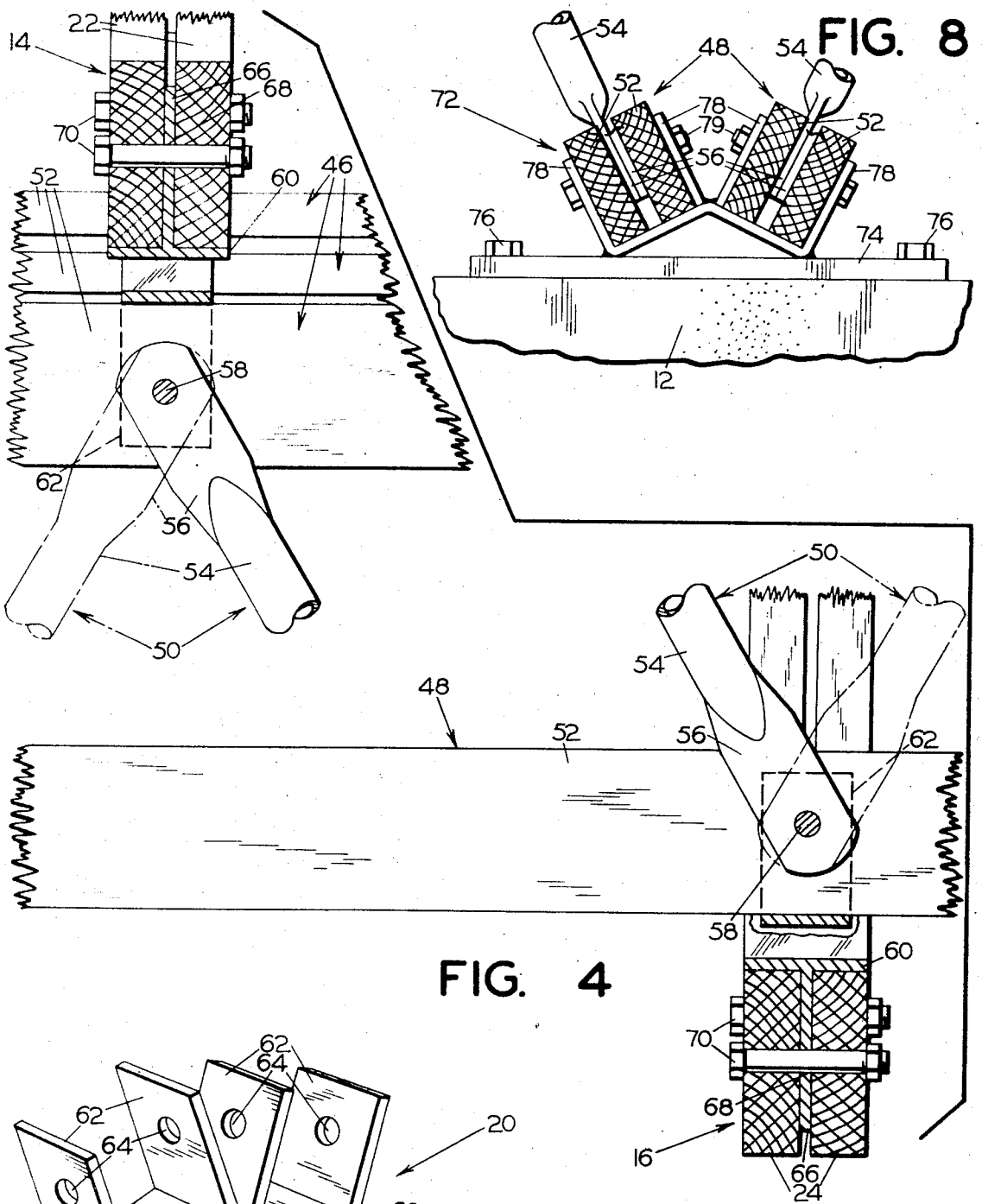


FIG. 8

FIG. 4

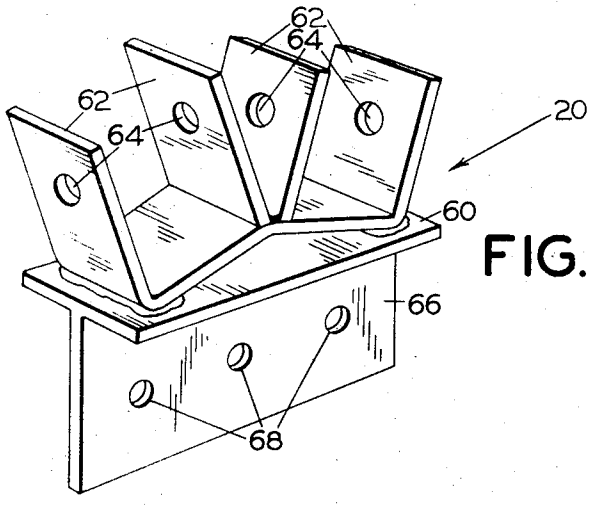


FIG. 5

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HEAVY DUTY SPACE FRAME FOUR-WAY SPACE FRAME

This invention relates to heavy duty space frames of the class designed to be used as floor or ceiling joist systems supported on rectangular bearing supports.

Although various types of structural space frames heretofore have been devised, the need exists for a space frame having the following advantages:

1. Capable of supporting massive loads.
2. Long span.
3. Adaptable to prefabrication.
4. Braced and stabilized to provide great strength.
5. Adaptable for mounting on conventional bearing supports.
6. Easily erected at the construction site without the necessity of elaborate staging, or theuse of massive hoisting equipment.
7. Of Simple, economical construction.
8. Efficient in the transmission to the supporting units of compression, tension and shear stresses in all directions.
9. Adaptable for use in a wide variety of structures.

The manner in which the foregoing and other objects of this invention are accomplished will be apparent from the accompanying specification and claims considered together with the drawings, wherein:

FIG. 1 is a fragmentary, plan view of the herein described space frame;

FIG. 2 is a fragmentary view in vertical section of the space frame;

FIG. 3 is a foreshortened, fragmentary, transverse sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is a foreshortened, fragmentary view in longitudinal section taken along line 4—4 of FIG. 3;

FIG. 5 is a perspective view of a connector employed in the space frame;

FIG. 6 is a fragmentary, transverse sectional view of the space frame illustrating a support means for the frame and its manner of application;

FIG. 7 is a fragmentary, sectional view taken along line 7—7 of FIG. 6; and

FIG. 8 is a fragmentary, sectional view similar to FIG. 6, but illustrating a second class of support means for the space frame.

Broadly considered, the presently described space frame comprises a plurality of spaced, substantially parallel chords arranged in upper and lower planes. The chords of each plane normally are laterally offset from the chords of the other plane in staggered arrangement.

A plurality of joist-type web members are disposed betweeen the chords of the two planes, transversely of the chords. Connecting means interconnect the upper and lower chords and web members. Support means support the chords and web members on bearing supports. The completed assembly thus becomes a two-way joist system whereof the web members comprise one set of joists and the transversely arranged chords interlocked with the web members comprise the second set of joists.

Considering the foregoing in greater detail:

The space frame of our invention is designed particularly for heavy duty, long span applications where intermediate supports are not required. It may be supported on any of the usual types of bearing supports in either lower chord bearing or upper chord bearing relation, preferably the former. The bearing supports may comprise timbers, glue-laminated beams, concrete walls, masonry walls, etc. The bearing supports normally would be arranged in rectangular outline, with one opposite pair **10** being at a lower elevation than the other opposite pair, **12**, FIG. **2**.

As seen in FIG. **3**, the space frame of our invention basically comprises a plurality of laterally spaced, substantially parallel, upper primary chords indicated generally at **14**, a plurality of spaced, lower primary chords, indicated generally at **16**, substantially parallel to each other and parallel to the upper chords; a plurality of web members indicated generally at **18**, arranged in pairs diagonally to each other and transversely of the chords; and connectors, indicated generally at **20**, which interconnect the chords and webs.

The structure of primary upper chords **14** and lower chords **16** may be substantially the same. In the illustrated form of the invention, each upper chord **14** comprises a pair of parallel, laterally spaced timbers **22** while each of lower chords **16** comprises a pair of parallel, laterally spaced timbers **24**. The timbers may comprise 2 × 4s, 2 × 6s, or other stock lumber pieces spliced together end to end, if necessary, to achieve the desired length.

Interconnecting upper and lower chords **14, 16** and in effect with them forming a first joist system are a plurality of web members **18**. These are disposed transversely of the joists, preferably at right angles thereto. In addition, they are disposed in pairs, the members of each pair being arranged diagonally to each other at an angle determined by such factors as the dimensions of the space frame and the stresses to which it is to be subjected. In the illustration, the web members are disposed at an angle of approximately 30° to the vertical.

Since a principal purpose of the invention is to provide a heavy duty, long-span space frame, web members **18** may comprise massive structural elements having a height of as much as 6 feet and a length of 100 feet or more. They may be of any suitable web construction, but preferably comprise joists in the form of trusses, particularly trusses comprising upper and lower chords interconnected by a zig-zag pattern of links. Each member thus comprises a joist disposed at right angles to the superimposed joist system including primary chords **14, 16**. This lends great strength and stability to the assembly.

As shown particularly in FIGS. **3** and **4**, each of web members **18** comprises an upper chord **46**, a lower chord **48** (not to be confused with primary chords **14, 16**), and a plurality of connecting links (webs) **50**.

The construction of upper chord **46** is substantially identical to that of lower chord **48**. Each comprises a pair of longitudinally extending, laterally spaced timbers **52**. Links **50** comprise tubular steel or aluminum members having bodies **54** and flattened ends **56**. Timbers **52** have lateral bores. Flattened ends **56** of links **50** have eyes which register with each other and with the bores and receive pins or bolts **58** by means of which the web members may be prefabricated at the factory.

Connecting means are provided for connecting web members **18** at the desired angle to each other and to primary chords **14, 16**. The construction and manner of application of the connecting members is illustrated particularly in FIGS. **3, 4** and **5**.

Each connector **20** comprises a base plate **60** which mounts on one face a pair of channel-shaped sockets

62, the side walls of which have registering openings 64. A tongue 66 extends outwardly from the opposite face of the base plate. It contains one or more transverse openings 68. The connector thus conveniently may be manufactured by welding together channel and T-segments of heavy gauge channel and T-bar stock, respectively.

The angle between sockets 62 corresponds to the angle of divergence desired between the members of each pair of web members 18. The sockets are dimensioned to receive chords 46, 48. They may be secured thereto by means of pins or bolts 58 which serve the dual functions of connecting links 54 to chords 46, 48, and sockets 62 to web members 18.

Tongue 66 is dimensioned to enter the space between the component timbers of primary chords 14, 16 in the manner shown in FIG. 2. It is held in place by suitable securing means such as bolts 70, thus connecting the web members to the primary chords.

The space frame is mounted on bearing supports 10, 12, supports 12 being at a higher elevation than are supports 10. This relationship exists, of course, to accommodate a difference in elevation between primary chords 16 and web members 18.

Web members 18 preferably are lower chord bearing on the supporting walls. A preferred manner of supporting them is illustrated in FIGS. 2 and 8.

Bearing connectors indicated generally at 72 anchor the web members to bearing supports 12, The bearing connectors have the same general construction as connectors 20 above described. However, in the manufacture of each of bearing connectors 72, tongue 66 of connector 20 is omitted. Instead, there is provided a base plate 74 having openings for the reception of stud bolts 76 which extend upwardly from bearing support 12. The base plate then mounts a pair of divergent, channel-shaped sockets 78 which receive lower chords 48 of trusses 18. The extreme ends of chords 48 may be received thus; or, if a cantilevered construction is contemplated, chord sections displaced inwardly from the chord ends may be received thus. The chords then are secured in the sockets by means of bolts or pins 79 which penetrate aligned openings in the side walls of sockets 78.

Primary chords 14, 16 are supported on opposite bearing walls 10. Preferably the lower chords are thus supported.

To this end portions of lower chords 16 are received in bearing connectors indicated generally at 80 of FIGS. 6 and 7. Although the bearing connectors may assume various configurations, in the illustrated form of the invention each one comprises a base plate 82 adapted to be connected to bearing support 10 by means of stud bolts 84 or other suitable means. The bearing plate is provided with a vertically extending T-shaped plate 86 which receives timbers 24, one on each side. Sockets 88 are welded to the outer surface of T-shaped plate 86. The sockets are arranged at the desired divergent angle to each other. They receive chords 48 to which they are fastened by means of bolts or pins 90. In this manner the elements of the space frame contemporaneously are interlocked with each other and with bearing supports 10.

There thus is provided a space frame assembly which lends itself to prefabrication in a central production area and to easy erection at a building site.

Web members 18 may be mass produced at the factory in the usual manner, with the minor variation that terminal pins 58 which connect chords 48 to links 54 at the terminal panel points are also used to mount connectors 20. The trusses then may be shipped to the building site and connected to upper and lower chords 14 and 16. This may be accomplished without the erection of elaborate staging and without the necessity of assembling the space frame on the ground and then employing massive hoists to lift the completed space frame into position.

In use, the performance of the space frame is also noteworthy. Since it basically consists of a two-way joist system, it is of great strength and lends itself to heavy duty, long span application. In this system each structural unit is braced and stabilized against the adjoining units. Both joist systems are continuous, thus requiring the use of but a fraction of the number of connecting elements required to connect the components of the conventional space frame.

The structure also is one which functions efficiently in transmitting the various stresses to which it is subjected to the underlying bearing supports. In the completed frame, truss chords 46, 48 take tension and compression stresses in the longitudinal direction while primary chords 14, 16 take tension and compression stresses in the transverse direction. Trusses 18, which form the web members in the truss system incorporating chords 14 and 16, take shear stresses in both the longitudinal and transverse directions. An assembly thus is provided which, in addition to being susceptible to prefabrication and easy assembly, is of great stability and strength.

Having thus described our invention in preferred embodiments, we claim:

1. A heavy duty space frame, comprising:
   a. a plurality of spaced, substantially parallel primary chords arranged in upper and lower planes, the chords of each plane being laterally offset from the chords of the other plane,
   b. a plurality of web members disposed in angularly divergent pairs between and transversely of the primary chords of the two planes, each web member forming a truss having upper and lower chords interconnected by a plurality of links arranged zigzag therebetween,
   c. a plurality of connector members for connecting the primary chords to the truss chords, each connector member comprising a base plate and a pair of socket members projecting from the base plate at the divergent angle of the pairs of web members and dimensioned to receive the truss chords therein,
   d. means for securing the primary chords to the base plates, and
   e. means for securing the truss chords to the socket members.

2. The space frame of claim 1 wherein each primary chord is formed of two laterally spaced segments and the base plate of each connector member includes a tongue projecting from the side of the base plate opposite the pair of socket members for reception between the two laterally spaced segments of the primary chords.

3. The space frame of claim 1 wherein each truss chord is formed of two laterally spaced segments, the links have flattened ends interposed between the later-

ally spaced segments, and the means for securing the truss chords to the socket members comprise pin means extending through the socket members, laterally spaced chord segments and flattened link ends.

4. The space frame of claim **1,** wherein each primary chord is formed of two laterally spaced segments, and including means for attaching the frame to underlying bearing supports arranged in opposite spaced pairs with one pair disposed perpendicularly to the other, said attaching means comprising

a. a plurality of primary chord supports each comprising a base plate, a central partition projecting upwardly from the base plate for reception between the two laterally spaced segments of the primary chords in said lower plane, a pair of socket members projecting upwardly from the central partition at the divergent angle of the pairs of web members and dimensioned to receive the lower truss chords therein,

b. means for securing the base plates of the primary chord supports to one of said pairs of bearing supports,

c. means for securing the lower truss chords to the socket members of each primary chord support,

d. a plurality of web member supports each comprising a base plate and a pair of socket members projecting upwardly therefrom at the divergent angle of the pairs of web members and dimensioned to receive the lower truss chords therein,

e. means for securing the base plates of the web member supports to the other of said pairs of bearing supports, and

f. means for securing the lower truss chords to the socket members of each web member support.

* * * * *