June 2, 1936. H. F. FREASE 2,042,779

JOIST FOR JOIST AND TILE CONSTRUCTION FOR FLOORS AND THE LIKE

Original Filed May 23, 1931 5 Sheets-Sheet 1

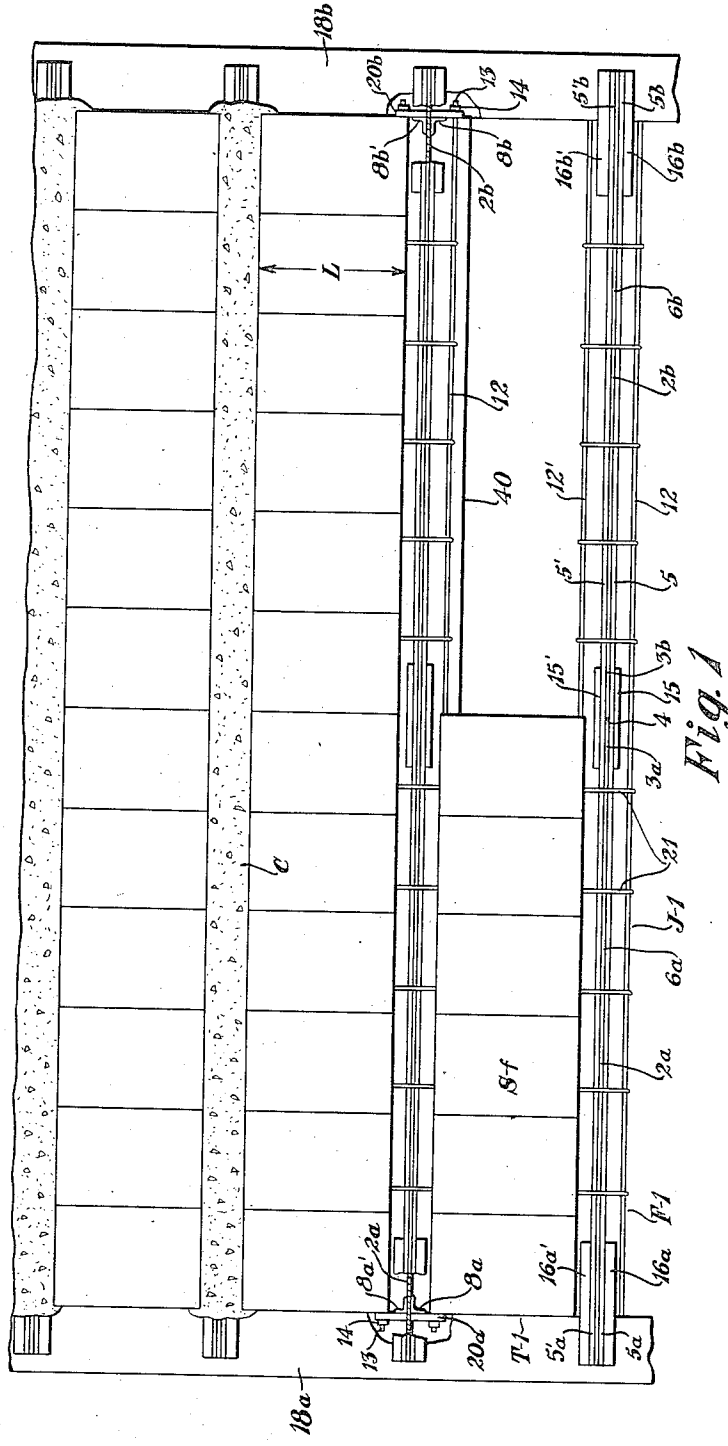

Fig. 1

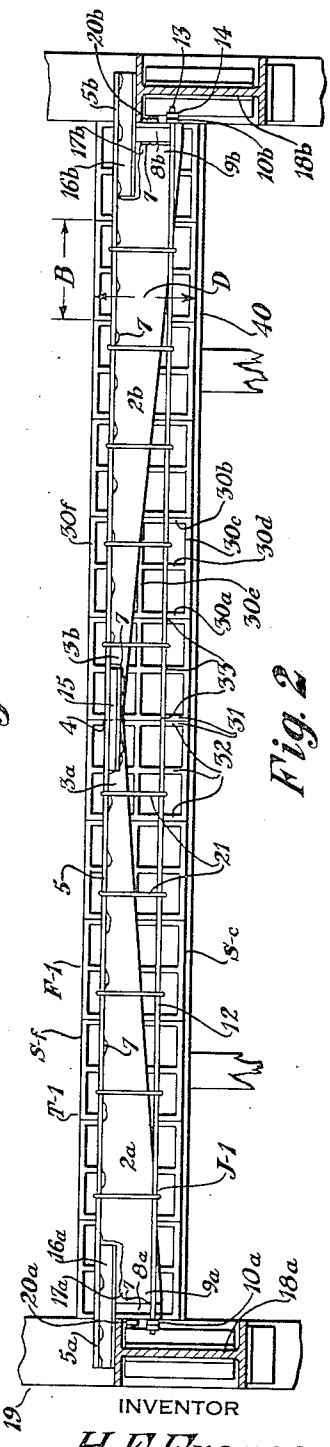

Fig. 2

INVENTOR

BY H. F. Frease

Frease and Bishop

ATTORNEYS

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JOIST FOR JOIST AND TILE CONSTRUCTION FOR FLOORS AND THE LIKE

Original Filed May 23, 1931 5 Sheets-Sheet 2

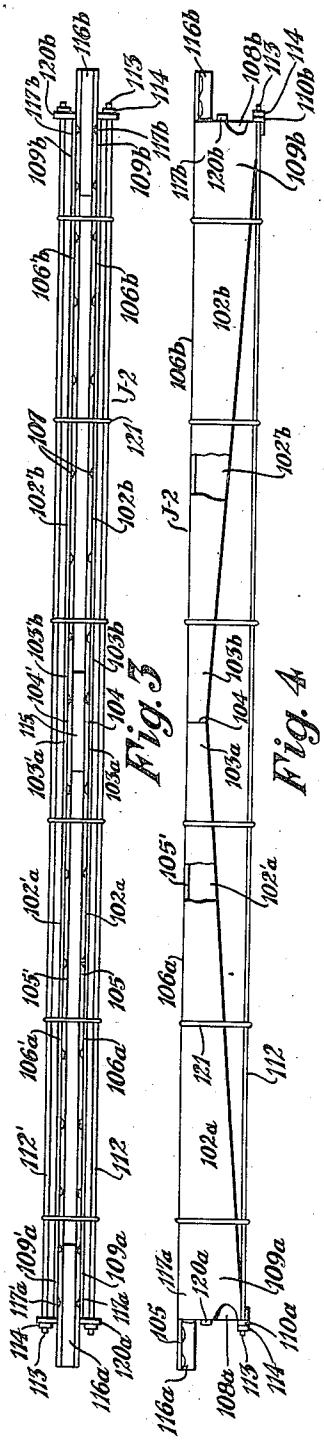

Fig. 3

Fig. 4

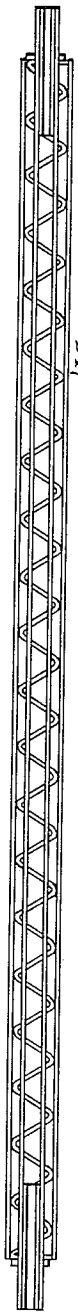

Fig. 5

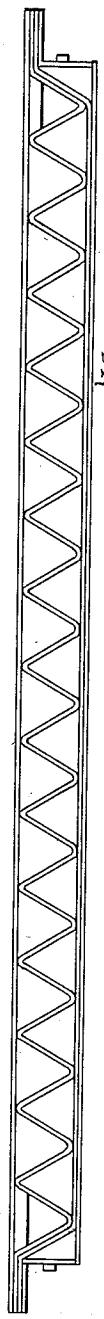

Fig. 6

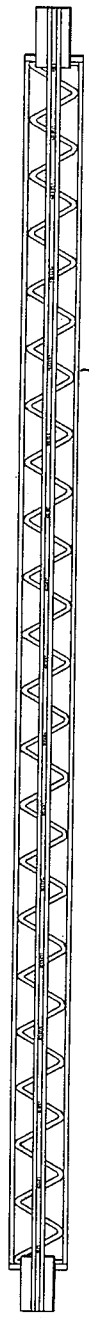

Fig. 7

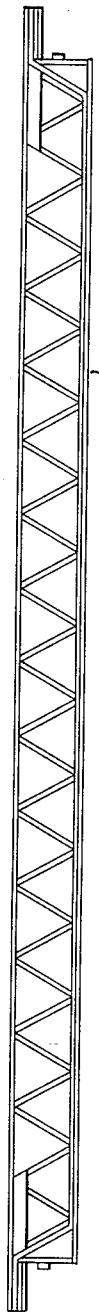

Fig. 8

INVENTOR

BY H.F. Frease

Frease and Bishop ATTORNEYS

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JOIST FOR JOIST AND TILE CONSTRUCTION FOR FLOORS AND THE LIKE

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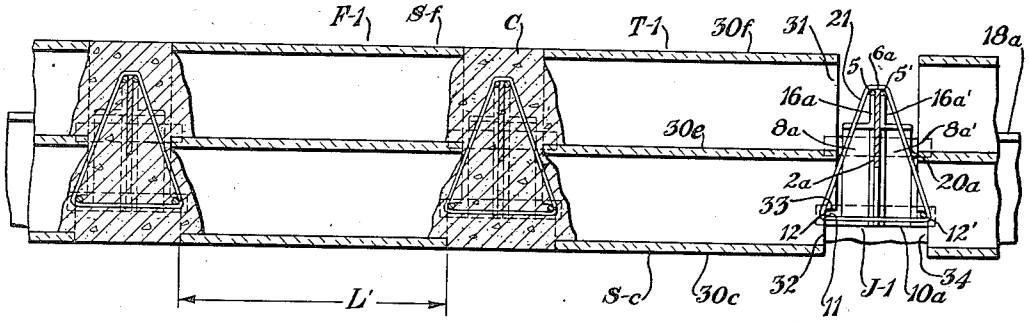

Fig. 9

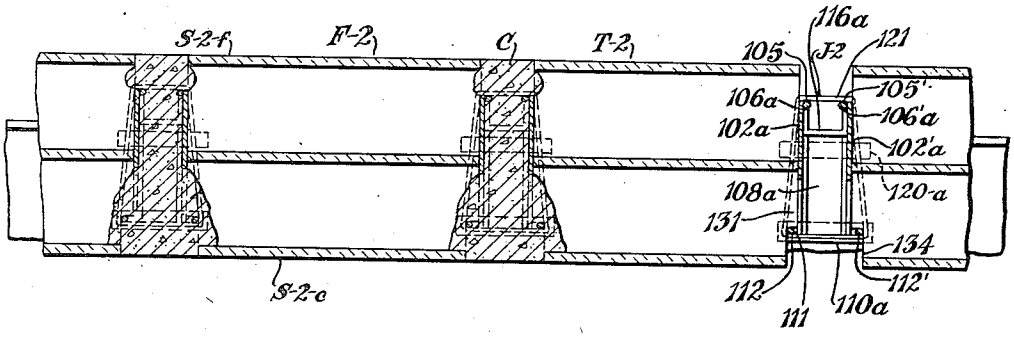

Fig. 10

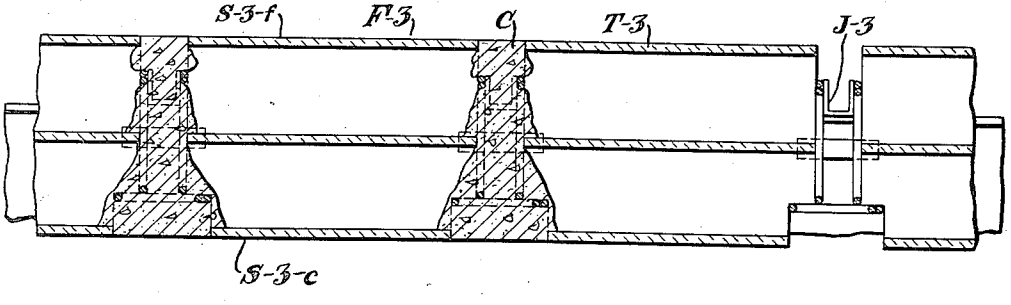

Fig. 11

INVENTOR

BY H. F. Frease

Frease and Bishop ATTORNEYS

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JOIST FOR JOIST AND TILE CONSTRUCTION FOR FLOORS AND THE LIKE

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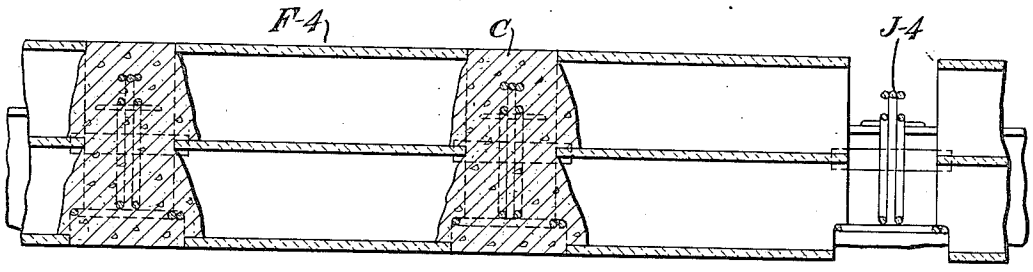

Fig. 12

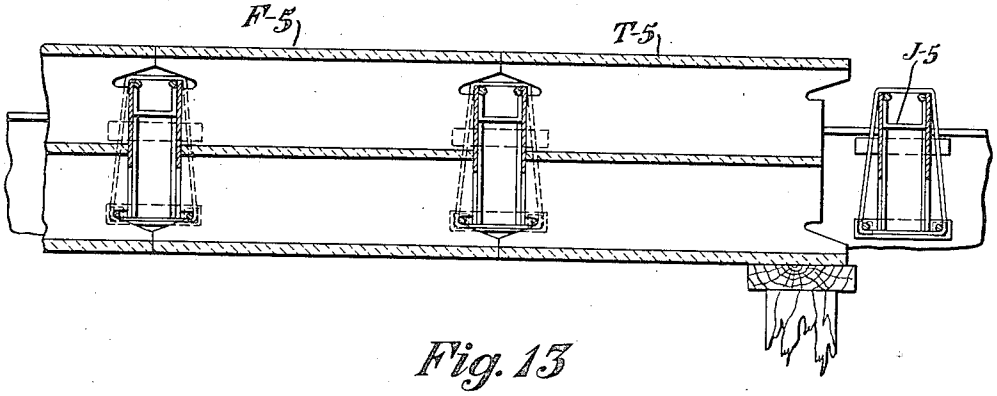

Fig. 13

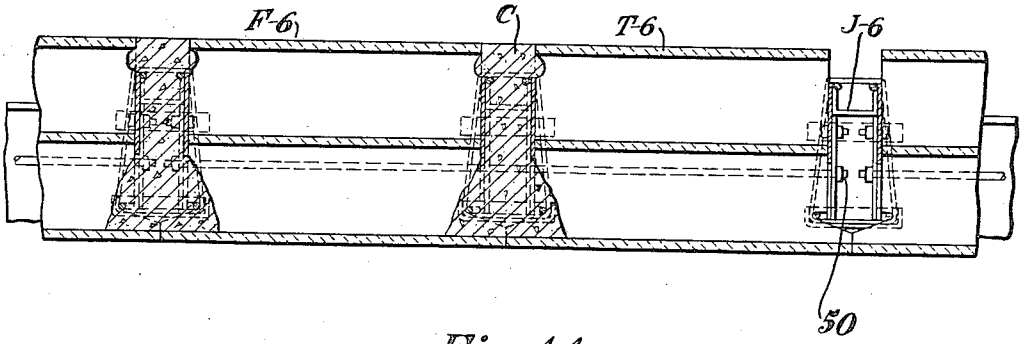

Fig. 14

INVENTOR

BY H. F. Frease

Frease and Bishop

ATTORNEYS

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JOIST FOR JOIST AND TILE CONSTRUCTION FOR FLOORS AND THE LIKE

Original Filed May 23, 1931 5 Sheets-Sheet 5

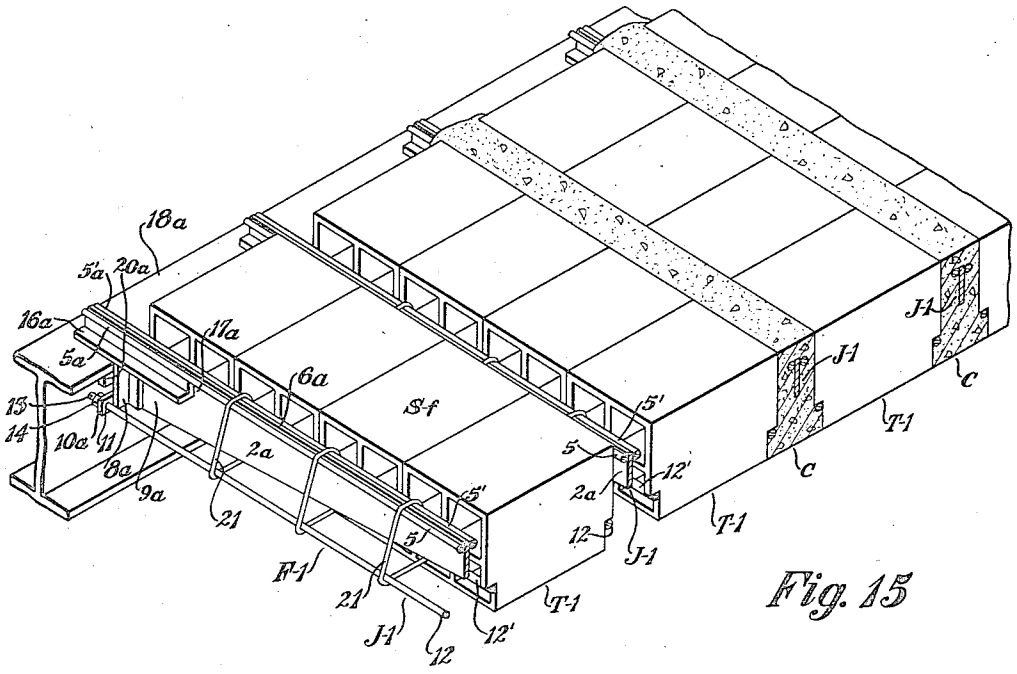

Fig. 15

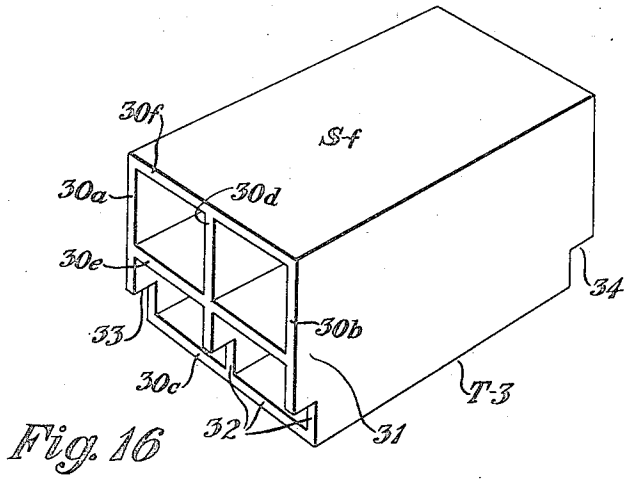

Fig. 16

INVENTOR

BY H. F. Frease

Frease and Bishop ATTORNEYS

Patented June 2, 1936 2,042,779

UNITED STATES PATENT OFFICE

2,042,779

JOIST FOR JOIST AND TILE CONSTRUCTION FOR FLOORS AND THE LIKE

Hurxthal F. Frease, Canton, Ohio

Original application May 23, 1931, Serial No. 539,545. Divided and this application December 12, 1932, Serial No. 646,867

13 Claims. (Cl. 72—61)

My invention relates to joist structures including longitudinally extending laterally spaced load sustaining joists or members supported at their ends, and surface forming members extending between the load sustaining members for forming spaced surfaces extending across the outer sides of the load sustaining members.

Such structures may include normally vertically extending walls, normally sloping roofs, or normally horizontal floors.

More particularly the present invention relates to joists for fire and heat resisting transverse load sustaining floors including preferably steel joists having upper and lower chord members and surface forming members supported by the joists and forming an upper floor surface and a lower ceiling surface extending respectively above and below the upper and and lower chord members of the joists.

The present invention is a division of subject matter set forth in my prior application for United States Letters Patent for Joist and tile construction for floors and the like, filed May 23, 1931, Serial No. 539,545.

In the usual steel joist floor construction, each joist includes transversely spaced longitudinally extending upper and lower chord members, means maintaining the chord members in proper load sustaining transversely spaced position, and end supports which rest upon spaced bearings such as beams.

The joists are laterally spaced from each other and extend longitudinally between the bearings, and metal lath or sheet metal decking extends across and is supported on the upper chords of the joists and is covered usually by a layer of concrete or other material for forming the upper floor surface, and in the case of office buildings, public buildings, residences, or the like, metal lath is usually suspended below the lower chords of the joists, and the lower metal lath is covered with coatings of plaster or the like for forming the lower ceiling surfaces.

Such usual steel joist floor construction, whether or not including a ceiling as aforesaid, does not satisfy the requirements of fire and heat resisting, or so-called "fire-proof", construction, because load sustaining members of the joists, and the inner surfaces of the lath are not provided with heat and fire resisting coverings such as concrete, tile, or the like, and may be subject to the direct action of heat or flames.

From the standpoint of erection however, joist floor construction is very desirable, because the joists for each floor may be placed in position on the bearing beams of the steel or other main frame of the building as it is erected, and temporary flooring may be laid over the joists for use during the further erection of the building, and for preventing workmen from falling.

When "fire-proof" construction is required however, it has heretofore been necessary to use some form of solid reinforced concrete floor, arch tile floor, tile or pan and reinforced concrete beam floor, or special or plural unit tile floor.

All of these usual types of "fire-proof" floors involve the use of concrete, grout, or mortar, and most of such floors require the use of separate forms or centering upon which the concrete is poured to make solid floors, or upon which concrete is combined with tile or pans, to make tile and concrete, or pan and concrete floors, or upon which tile is laid up with mortar by masons to make tile arch floors.

Some forms of the special or plural unit tile floor eliminate centering by the use of tile having an unusual or special transverse cross section, or by the use of a plurality of sets of tile units, the unit of each set having a transverse cross section, different from the other set units. Such special tile or sets of special tile are very objectionable from the standpoint of the tile manufacturer, because special dies are required for forming the tile, and because it is very difficult to maintain an adequate supply of the special units to meet the requirements of builders in various parts of the country.

From the standpoint of erection the usual workmen available for building purposes have difficulty in properly positioning and arranging the several different shapes or units of tile in plural unit construction.

Moreover, aside from the standpoint of fireproofing, all joist floor constructions commercially available prior to the present invention, have required the combination of more than two different or separate elements, other than concrete, grout, or mortar, to provide self-sustaining structures having spaced flat floor and ceiling surfaces.

The objects of the present invention are in general to provide joists adapted to improve and reduce the cost of joist and tile construction, and specifically are as follows:

First, to provide joists for a self-sustaining structure including spaced flat outer surfaces, and which includes, excepting concrete, grout, or other similar material when used, only two different sets of elements, namely a set of laterally spaced similar load sustaining elements

or joists, and a single set of similar surface forming elements, preferably refractory tile, the surface forming elements spanning between and being supported by the joists;

Second, to provide joists for a self-sustaining joist and tile structure which is adapted for meeting the most rigid fire-proofing requirements, and which may be constructed at a minimum cost;

Third, to provide joists for a joist and tile structure in which the joists support the tile, and in which the tile have a rectangular cross-section, whereby the tile may be made in any usual building tile manufacturing plant without requiring special dies;

Fourth, to provide joists for a "fire-proof" joist and tile structure in which the use of concrete, grout, or similar material is optional;

Fifth, to provide joists for a self-sustaining joist and tile structure adapted for supporting transverse loads, and in which all the elements including concrete, grout, or similar material when used, cooperate with each other to attain the maximum efficiency of each separate element; that is to say the steel of the joist is subject to a maximum tension and a minimum compression loading, the tile is subject to a maximum compression and shear loading and a minimum tension loading, and the concrete, grout or similar material when used is subject to a maximum compression and shear loading and a minimum tension loading, or if desired, the concrete may be subject to no structural loading whatever;

Sixth, to provide joists for a joist and tile structure, in which the joist and tile elements after being properly installed, permanently position and interlock each other without additional means, and the complete structure when used as a floor being adapted to resist lateral twisting of the main frame of the building, as the result of wind pressure and the like;

Seventh, to provide joists for a joist and tile structure particularly adapted for permitting the use of rectangular tile of relatively great length; and

Eighth, to provide improved joists particularly adapted for combination with improved tile to form improved joist and tile structures.

The foregoing and other objects are attained by the structures, parts, improvements, and combinations, which comprise the present invention, and which are particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

In general terms the improved structures may be described as including the improved laterally spaced longitudinally extending load sustaining spanning members or joists hereof, and improved surface forming members or blocks extending between the spanning members and forming spaced flat surfaces extending across the outer sides of the spanning members, each improved spanning member including one or more longitudinally extending upper chord members, one or more longitudinally extending lower chord members, and means maintaining the chord members in proper load sustaining position, each lower chord member being laterally as well as transversely spaced from one of the upper chord members, and the improved blocks preferably comprising refractory tile, each block preferably having a rectangular transverse cross-section and extending between adjacent spanning members, and each block preferably having a notched seat formed in each of its lower end corners, whereby each end of each block is supported on one of the lower chord members of one of the spanning members, and the lower portion of each end of each block may be formed for extending beneath the chord member supporting the block and forming a concrete or grout retaining shelf, and when it is desired to eliminate the use of concrete, grout or the like, the upper portion of each end of each block may be formed for extending over one or more of the upper chord members, and the ends of the block may be positively engaged by concrete or grout when the same is used to embed the spanning members, and preferably the ends of the blocks abut against sides of the load sustaining members for interlocking with the load sustaining members, whether or not concrete or other embedding material is used.

Preferred embodiments of the invention are illustrated in the accompanying drawings forming part hereof, in which

Figure 1 is a top plan view illustrating one embodiment of the improved joist and tile floor structure, including one form of improved lever arch joist hereof, and one form of improved end notched tile, portions of the floor being illustrated finished, and other portions being illustrated during the course of construction;

Fig. 2, a sectional view thereof looking at the side of one of the joists;

Fig. 3, a top plan view of another form of improved lever arch joist hereof particularly adapted for the improved joist and tile floor structure;

Fig. 4, a side elevation thereof;

Fig. 5, a top plan view of a form of improved bar joist hereof particularly adapted for the improved joist and tile floor structure;

Fig. 6, a side elevation thereof;

Fig. 7, a top plan view of another form of improved bar joist hereof for use in the improved joist and tile floor structure;

Fig. 8, a side elevation thereof;

Fig. 9, an enlarged fragmentary transverse sectional view of the floor structure illustrated in Figs. 1 and 2;

Fig. 10, a similar view illustrating the use of the joist of Figs. 3 and 4 with tile similar to the tile of Figs. 1, 2, and 9;

Fig. 11, a similar view illustrating the use of the joist of Figs. 5 and 6 with tile similar to the tile of Figs. 1, 2, and 9;

Fig. 12, a similar view illustrating the use of the joist of Figs. 7 and 8 with tile similar to the tile of Figs. 1, 2, and 9;

Fig. 13, a similar view illustrating another embodiment of the improved joist and tile structure including the joist of Figs. 3 and 4, and a second embodiment of the improved tile, and in which no concrete is used, and the method of erection being indicated.

Fig. 14, a similar view illustrating another embodiment of the improved joist and tile floor structure including the joist of Figs. 3 and 4, and a third embodiment of the improved tile, together with concrete embedding the joist and tile, the tile being formed so as to eliminate the necessity of separate forms or centering for receiving the concrete when poured.

Fig. 15, a fragmentary isometric perspective view of the floor structure of Fig. 1; and

Fig. 16, an isometric perspective view of one of the improved tile.

Similar numerals refer to similar parts throughout the drawings.

One embodiment of the improved joist and tile

floor structure is indicated general at F—1 in Figs. 1, 2, and 9. The floor structure F—1 includes a plurality of laterally spaced longitudinally extending improved load sustaining spanning members each indicated generally by J—1, and a plurality of improved surface forming tile or blocks each indicated generally by T—1, the blocks T—1 extending between and bearing on adjacent spanning members J—1, and forming a spaced flat upper floor surface S—*f* and a spaced flat lower ceiling surface S—*c* extending respectively above and below the spanning members J—1.

Each improved spanning member J—1 is preferably an improved embodiment of the lever arch joists set forth in my prior United States Letters Patent No. 1,686,910, and in my prior applications for United States Letters Patent, Serial No. 129,424, and Serial No. 280,484.

For attaining the particular objects of the present invention, each of the improved spanning members or lever arch joists indicated generally by J—1, includes triangular arch struts 2*a* and 2*b* which may be formed by diagonally severing a rectangular plate.

The struts 2*a* and 2*b* are arranged with their apexes 3*a* and 3*b* preferably abutting each other, as at 4.

A pair of laterally spaced longitudinally extending upper chord members or bars 5 and 5′ are secured along the upper edges 6*a* and 6*b* of the struts 2*a* and 2*b*, as by arc welds 7; and the bars 5 and 5′ respectively are preferably provided with terminals 5*a* and 5*b*, and 5′*a* and 5′*b* extending beyond the ends of the arch struts 2*a* and 2*b*.

Heel struts 8*a* and 8*a*′ are secured, as by arc welds 7, on opposite sides of the base 9*a* of the arch strut 2*a*; and heel struts 8*b* and 8*b*′ are secured, as by arc welds 7, on opposite sides of the base 9*b* of the arch strut 2*b*.

Each heel strut, as illustrated, is preferably a length of standard angle, and the apex of each angle heel strut extends transversely of its joist, and one leg of each angle heel strut abuts the side face of the arch strut to which it is secured, and the other leg of each angle heel strut extends laterally outwardly from the side of the arch strut to which it is secured, the laterally extending legs of the angle heel struts being preferably located at the outer edges of the bases 9*a* and 9*b* of the arch struts 2*a* and 2*b* respectively.

Laterally extending tie rod spacing and anchor members 10*a* and 10*b* are secured respectively as by arc welds 7 on the outer faces of the laterally extending legs of the angle heel struts 8*a* and 8*a*′, and 8*b* and 8*b*′, at the lower ends thereof.

Each laterally extending tie rod spacing and anchor member is secured at its central portion to its pair of angle heel struts, and extends laterally from each side of the arch strut to which its angle heel struts are secured.

The outer end of each tie rod spacing and anchor member has formed therein a tie rod receiving aperture 11.

Laterally spaced longitudinally extending tie rods 12 and 12′ are each provided with threaded outer ends 13 each of which extends through one of the apertures 11, and a nut 14 is screwed upon each threaded tie rod end 13, and the nuts 14 react against the outer faces of the tie rod spacing and anchor members 10*a* and 10*b*, and apply suitable tension loads on the tie rods 12 and 12′.

For resisting lateral displacement of the arch strut apexes 3*a* and 3*b*, and for resisting abnormal reverse or vibration loading of the joist, a pair of longitudinally extending reinforcing angles 15 and 15′ may be secured as by arc welds 7 to the apexes 3*a* and 3*b* of the struts 2*a* and 2*b*, on opposite sides thereof, with one leg of each angle spaced below one of the chord members or bars 5 and 5′ and extending laterally from the side faces of the arch struts to which particular reinforcing angle is secured.

For providing end supports for the arch joist J—1 above the laterally spaced tie rods 12 and 12′, laterally spaced angle end supports 16*a* and 16*a*′, and 16*b* and 16*b*′, are secured as by arc welds 7, on opposite sides and at the upper outer corners 17*a* and 17*b* of the struts 2*a* and 2*b*, respectively, and the angle end supports are transversely spaced above the tie rods 12 and 12′, that is to say under the normal use of the arch joists J—1, the lever end supports are above the tie rods and the end supports extend longitudinally beyond the ends of the arch joists any desired distance coextensive with the terminals 5*a* and 5*b*, and 5*a*′ and 5*b*′ of the chord bars 5 and 5′, and the angle end supports and the chord bar terminals are preferably secured to each other as by arc welds 7.

Each arch joint J—1 is pendulously supported at its ends by resting the angle end supports 16*a* and 16*a*′, and 16*b* and 16*b*′, respectively, on suitable bearings, which may be beams 18*a* and 18*b*, respectively, of the main frame of a building indicated generally by 19.

For attaining the most efficient co-action between the improved joist load sustaining members J—1 and the preferred refractory tile surface forming members T—1, each joist J—1 includes tile clamping bars 20*a* and 20*b* secured respectively as by arc welds 7 on the outer faces of the laterally extending legs of the angle heel struts 8*a* and 8*a*′, and 8*b* and 8*b*′, above the tie rod spacing and anchor members 10*a* and 10*b*, respectively.

The tile clamping bars 20*a* and 20*b* thus secured respectively on the outer ends of the bases 9*a* and 9*b* of the arch struts 2*a* and 2*b*, co-act with the tile T—1, in an improved manner which will be hereinafter described in detail.

In other words each of the improved joist load sustaining members J—1 includes longitudinally extending upper chord members 5 and 5′, longitudinally extending lower tie rod or chord members 12 and 12′, arch means maintaining the chord members in proper load sustaining position, and end supports for pendulously supporting the joists.

The lower chord members 12 and 12′ are transversely spaced below and laterally spaced at opposite sides of the upper chord members 5 and 5′, and certain of the objects of the present improvements are attained by utilizing the laterally spaced lower chord members as bearings for the lower ends of the tile T—1.

The lower tie rod or chord members 12 and 12′ may each in itself have a suitable cross-section for resisting deflection when the tile T—1 are being placed in position, it being understood that as hereinafter set forth in detail, after the tile T—1 are placed in position the joists J—1 co-act with the tile T—1 under load so as to oppose transverse deflection.

As illustrated, however, a plurality of longitudinally spaced closed triangular hanger frames 21 are applied around the upper chord members 5 and 5′ and the lower tie rods 12 and 12′, the upper chord members and the lower tie rod members being secured respectively as by weld-

ing at the apexes of the triangular hanger frame 21 which may be conveniently formed of wire.

Each of the preferred refractory tile surface forming members T—1, is preferably a hollow tile having a rectangular transverse cross-section and including normally horizontal upper and lower rectangular walls 30*f* and 30*c* whose outer surfaces respectively form the floor surface S—*f* and the ceiling surface S—*c*. Outer normally vertical longitudinally extending rectangular side walls 30*a* and 30*b* extend between the longitudinal side edges of the walls 30*f* and 30*c*, and a normally vertical longitudinally extending rectangular reinforcing web wall 30*d* may extend between the upper and lower walls 30*f* and 30*c*, and when desired a normally horizontal longitudinally extending rectangular reinforcing web wall 30*e* may extend between the side walls 30*a* and 30*b* and intersect the vertical web wall 30*d*.

At each end of each tile, an upper end supporting portion 31, including upper end portions of the side walls 30*a* and 30*b*, and of the vertical web wall 30*d*, together with the upper wall 30*f* and the horizontal web wall 30*d*, extends longitudinally beyond preferably vertically offset lower faces 32 including lower portions of the end faces of the side walls 30*a* and 30*b*, and of the vertical web wall 30*d*, and the end face of the bottom wall 30*c*.

The lower longitudinally extending faces 33 of each end supporting portion 31 are formed by the lower faces of the longitudinally extending upper end portions of the side walls 30*a* and 30*b*, and of the vertical web wall 30*d*, and are normally horizontal, and the normally horizontal faces 33 form with the normally vertical faces 32 a notched or rabbeted seat indicated generally by 34 in each lower end corner of each tile.

In other words the improved tile T—1, with the desired upper longitudinally extending end supporting portion 31, at each end thereof, may be formed by notching out each lower end corner of an ordinary green rectangular building tile during the process of manufacture, by the use of hand notching wires, or machines, well known in the art.

As illustrated all the outer faces of the upper and lower walls 30*f* and 30*c* and the side walls 30*a* and 30*b* of each tile, are smooth, and may be glazed; whereby in certain classes of construction no further floor or ceiling finish need be applied over the outer surfaces of the upper and lower walls 30*f* and 30*c*, whereby a glazed tile floor and ceiling finish is obtained.

When desired, it is obvious however that the outer surfaces of the upper, lower, and side walls of each tile may be longitudinally tongued and grooved in the well known manner for receiving finishing concrete, plaster, grout, or the like.

In order to obtain the maximum advantages of the present improvements, it is desirable that the overall length L of each tile be substantially longer than the corresponding dimension of tile used in other types of tile floor construction.

This overall length L may be 18 inches, 24 inches, 36 inches or even longer depending upon loading and dimensional requirements.

In any event the greatest efficiency is obtained when the overall length L is greater than the lateral breadth B of the tile, and is also greater than the transverse depth D.

In erecting the floor F—1, the spanning joist members J—1 are placed in position so that their end supports 16*a* and 16*a'*, and 16*b* and 16*b'*, rest on the bearing beams 18*a* and 18*b*, respectively, and the joists J—1 are laterally spaced from each other so that the distance between the tie rod 12 of one joist and the tie rod 12' of the next adjacent joist is substantially equal to the length L' between the opposite offset lower faces 32 of the lower end portions of the side walls 30*a* and 30*b*, the web wall 30*d*, and the lower ceiling forming wall 30*c* of each tile T—1.

Temporary flooring may then be laid across the arch struts 2*a* and 2*b* of the joists, and the tile or blocks T—1 may be laid directly from above so that each end supporting portion 31 rests on the adjacent tie rod 12 or 12' of the adjacent joist, the length L of the upper walls 30*f* and the upper end portions of the side walls 30*a* and 30*b* and the web wall 30*d* of each tile T—1 is such that the extremities of the end adjacent tile carried by the tie rods 12 and 12' of any particular joist J—1 are laterally spaced from each other and from the upper chord bars 5 and 5', a distance to permit concrete, grout, or other compression resisting, self-setting plastic material C to be poured downwardly between the laterally spaced tile end portions and the upper chord bars 5 and 5' of the joist. A centering plank 40 may be supported or suspended in abutment with the outer faces of adjacent lower end portions of the lower walls 30*c*, for receiving the plastic material C when it is poured, and until it is set.

As best illustrated in Fig. 9, in the resulting floor structure F—1, the compression resisting concrete material C completely embeds each joist, and engages with the end portions of the tile walls.

It is also to be noted that the notched seats 34 of the tile interlock with the supporting tie rods 12 and 12' of the joists J—1.

In the floor F—1 the side walls of adjacent tile abut against each other and clamping pressure is applied against the side abutting tile T—1, due to the weight of the floor itself, and any transverse loading thereof, acting through the longitudinally spaced clamping bars 20*a* and 20*b* between which the tile T—1 are located.

It will also be noted that normal transverse loading of the floor F—1 places the concrete C under compression between the laterally extending flanges of the angle heel struts of each joist J—1.

From another standpoint, in the floor F—1, each tile or block extends between and bears on adjacent spanning joists J—1, and the outer faces of the walls 30*f* and 30*c* are transversely spaced from each other and have side edges abutting each other.

The outer faces of all the upper floor walls 30*f* of the adjacent tile T—1 between any two adjacent joists are alined with each other, and similarly the outer faces of all the lower ceiling walls 30*c* of the adjacent tile between any two adjacent joists are alined with each other, and the transversely spaced alined outer faces of the walls 30*f* and 30*c* form with the outer faces of the concrete C the transversely spaced floor and ceiling surfaces S—*f* and S—*c*, each extending laterally and longitudinally with respect to the spanning joists J—1, and the transverse spacing between the upper chord members 5 and 5' and the lower chord members 12 and 12' of the spanning joists is less than the transverse spacing of the surfaces S—*f* and S—*c*, and the transversely spaced upper and lower chord members 5 and 5', and 12 and 12' are located between the transversely spaced surfaces S—*f* and S—*c*,

whereby the desired floor structure having the transversely spaced flat floor and ceiling surfaces S—*f* and S—*c* is attained by the use of only a plurality of the joists J—1, a plurality of the unitary similar tile T—1, and the concrete C.

A second embodiment of the improved joist and tile floor structure is indicated generally at F—2 in Fig. 10, and includes a plurality of laterally spaced longitudinally extending improved load sustaining spanning members each indicated generally by J—2, and a plurality of improved surface forming tile or block each indicated generally by T—2 and extending between and bearing on adjacent spanning members J—2 and forming a flat upper floor surface S—2—*f* and a flat lower ceiling surface S—2—*c*, the surfaces S—2—*f* and S—2—*c* being transversely spaced from each other and extending respectively above and below the spanning members J—2.

The spanning members J—2 constitute other embodiments of the lever arch joists, set forth in my aforesaid prior United States Letters Patent and applications, and are further improvements of the joists J—1, whereby the quantity of concrete required for making a "fireproof" floor is reduced and the structural coaction of the joists and tile is improved in the floor F—2.

One of the improved joists J—2, detached from the floor structure F—2, is illustrated in Figs. 3 and 4, and includes triangular arch struts 102*a* and 102*b*, and 102'*a* and 102'*b*.

The struts 102*a* and 102*b* are arranged with their apexes 103*a* and 103*b* abutting each other as at 104; and the struts 102'*a* and 102'*b* are arranged with their apexes 103'*a* and 103'*b* abutting each other as at 104', and the struts 102*a* and 102*b* are spaced laterally from the struts 102'*a* and 102'*b*.

An upper chord member or bar 105 is secured along the upper edges 106*a* and 106*b* of the struts 102*a* and 102*b*, as by arc welds 107; and laterally spaced from the bar 105, a chord member or bar 105' is secured along the upper edges 106'*a* and 106'*b* of the struts 102'*a* and 102'*b*, as by arc welds 107.

A channel heel strut 108*a* is interposed between the bases 109*a* and 109'*a* of the laterally spaced arch struts 102*a* and 102'*a* and secured thereto as by arc welds 107; and a channel heel strut 108*b* is interposed between the bases 109*b* and 109'*b* of the laterally spaced arch struts 102*b* and 102'*b* and secured thereto as by arc welds 107.

Laterally extending tie rod spacing and anchor members 110*a* and 110*b* are secured respectively as by arc welds 107 on the outer faces of the channel struts 108*a* and 108*b* respectively at the lower ends thereof.

Each laterally extending tie rod spacing and anchor member is secured at its central portion to its channel heel strut and extends laterally from each side thereof and from the opposite sides of the arch struts spaced by the channel heel strut.

The outer end of each tie rod spacing and anchor member has formed therein a tie rod receiving aperture 111.

Laterally spaced longitudinally extending tie rods 112 and 112' are each provided with threaded outer ends 113 each of which extends through one of the apertures 111 and a nut 114 is screwed upon each threaded tie rod end 113 and the nuts 114 react against the outer faces of the tie rod spacing and anchor members 110*a* and 110*b*, and apply suitable tension loads on the tie rods 112 and 112'.

The lower tie rods or chord members 112 and 112' are transversely spaced below and laterally spaced at opposite sides of the upper laterally spaced shord members 105 and 105', and their respective arch struts.

For resisting lateral displacement of the arch strut apexes, and for resisting abnormal reverse or vibration loading of the joists J—2 a longitudinally extending channel 115 is preferably interposed between the strut apexes 103*a* and 103*b*, and the strut apexes 103'*a* and 103'*b* and secured thereto as by arc welds 107.

For providing end supports for the arch joists J—2 above the laterally spaced tie rods 112 and 112', a preferably channel end support 116*a* is interposed between the upper outer corners 117*a* and 117'*a* of the struts 102*a* and 102'*a*, and secured thereto as by arc welds 107; and similarly a channel end support 116*b* is interposed between the upper outer corners 117*b* and 117'*b* of the struts 102*b* and 102'*b* respectively, and secured thereto as by arc welds 107.

The end support 116*a* extends longitudinally beyond the arch strut bases 109*a* and 109'*a* and the channel end support 116*b* extends longitudinally beyond the arch strut bases 109*b* and 109'*b*.

Each joist J—2 preferably further includes tile clamping bars 120*a* and 120*b* secured respectively by arc welds 107 on the outer faces of the channel heel struts 108*a* and 108*b*, above the tie rod spacing and anchor members 110*a* and 110*b*, respectively.

A plurality of longitudinally spaced closed trapezoidal hanger frames 121 are applied about the upper chord members 105 and 105' and the lower tie rods 112 and 112', and the upper chord members and lower tie rod members are preferably secured respectively as by welding at the apexes of the trapezoidal hanger frames 121.

The preferably refractory tile or blocks T—2 are similar in form to the tile T—1, and include spaced end supporting portions 131 formed by providing notched or rabbeted seats indicated at 134 in each lower end corner of each tile.

In erecting the floor F—2 the spanning joist members J—2 are placed in position so that their end supports 116*a* and 116*b* rest on spaced bearing beams, not shown, and the joists J—2 are laterally spaced from each other in a manner similar to that described for the joists J—1 of the floor F—1.

The tile T—2 are then laid in a manner similar to that described for the positioning of the blocks T—1, the principal difference between the floor F—2 and the floor F—1 arising from the use of the upper laterally spaced chord members 5 and 5' and the arch struts therefor, whereby in the floor F—2 the concrete material C may be poured downwardly between the upper chord bars 105 and 105' of the joists, and also the ends of the tile J—2 may preferably abut directly against the sides of the adjacent arch struts for effecting an interlocking structural coaction between the joists J—2 and the tile T—2.

The third embodiment of the improved floor structure is indicated generally at F—3 in Fig. 11, and is generally similar to the floor F—2. The floor F—3 includes laterally spaced longitudinally extending spanning joists J—3 and a plurality of tile or blocks T—3 extending between and bearing on adjacent spanning members J—3, and forming a flat upper floor surface S—3—*f* and a flat lower ceiling surface S—3—*c*, the surfaces S—3—*f* and S—3—*c* being transversely spaced from each other and ex-

tending respectively above and below the spanning joist members J—3.

The joist members J—3 are identical in manner of use with the joist members J—2, but are made as illustrated by the use of truss construction rather than arch construction.

One of the joists J—3 is illustrated in detail in Figs. 5 and 6.

A fourth embodiment of the improved floor structure is indicated generally at F—4 in Fig. 12, and is generally similar to the floor structure F—1, but includes the use of trussed joists J—4, one of which is illustrated in detail in Figs. 7 and 8.

The fifth embodiment of the improved floor structure indicated generally at F—5 in Fig. 13, includes arch joists J—5 which are structurally similar to the arch joists J—2, and tile or blocks T—5, each end of each of which is formed as illustrated for bearing on one of the joists J—5 and for extending above and below the joists J—5 thereby totally inclosing the joists between the ends of end adjacent tiles T—5. The tiles T—5 preferably abut each other sidewise as well as endwise, and the floor F—5 is erected as indicated in Fig. 13 by laterally sliding each joist J—5 into the alined formed ends of a temporarily supported row of the tile T—5.

The sixth embodiment of the improved floor structure indicated generally by F—6 in Fig. 14, is generally similar to the floor F—5, with the exception that the joists J—6 of the floor F—6 are connected with each other laterally as by laterally extending rods 50 each end of which is connected with one of the laterally spaced arch struts of one of the joists J—6, which are structurally similar to the joists J—2.

The tile T—6 of the floor F—6 are each so formed that each end extends below its supporting joist J—6 forming a shelf upon which the concrete C may be poured.

It will be observed that each of the improved joists J—1 to J—6, inclusive, comprises a self-sustaining and load sustaining spanning structure including transversely spaced longitudinally extending chord members and means, either arch strut means or truss means, which maintain the chord members in load sustaining positions throughout the span length thereof.

Each joist or self-sustaining and load sustaining spanning structure also preferably includes laterally spaced normally lower chord members and preferably laterally spaced normally upper chord members located between normally vertical planes passing through the lower chord members, whereby the lower chord members are adapted to support the tile of the several floors F—1 to F—6, inclusive.

Each of the joists or self-sustaining and load sustaining spanning structure furthermore preferably includes a longitudinally extending end support at each end thereof and also preferably includes longitudinally spaced clamping bars preferably secured at opposite ends of the structure and extending laterally beyond opposite sides of the normally upper chord member or members and being adapted to clamp the tile supported on the normally lower chord members.

Moreover, in each joist, the chord members through the entire span length thereof, are maintained in load sustaining relationship with each other by the triangular arch struts of the joists J—1 and J—2 or by the trussing of the joists J—3 to J—6, inclusive, each of which may be termed truss means.

I claim:

1. A self-sustaining and load sustaining spanning structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and a normally upper chord member located between normally vertical planes passing through the normally lower chord members.

2. A self-sustaining and load sustaining spanning structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members laterally spaced from each other and the upper chord members being located between normally vertical planes passing through the normally lower chord members.

3. A self-sustaining and load sustaining spanning structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members located between normally vertical planes passing through the normally lower chord members.

4. A self-sustaining and load sustaining spanning structure for use as a joist and the like, the structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and a normally upper chord member located between normally vertical planes passing through the normally lower chord members, and longitudinally spaced laterally extending clamping bars operatively associated with some of the members, the clamping bars extending laterally beyond opposite sides of the normally upper chord member and being adapted to clamp tile and the like supported on the normally lower chord members.

5. A self-sustaining and load sustaining spanning structure for use as a joist and the like, the structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members laterally spaced from each other and the upper chord members being located between normally vertical planes passing through the normally lower chord members, and longitudinally spaced laterally extending clamping bars operatively associated with some of the members, the clamping bars extending laterally beyond opposite sides of the normally upper chord members and being adapted to clamp tile and the like supported on the normally lower chord members.

6. A self-sustaining and load sustaining spanning structure for use as a joist and the like, the structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load

sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members located between normally vertical planes passing through the normally lower chord members, and longitudinally spaced laterally extending clamping bars operatively associated with some of the members, the clamping bars extending laterally beyond opposite sides of the normally upper chord members and being adapted to clamp tile and the like supported on the normally lower chord members.

7. A self-sustaining and load sustaining spanning structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and a normally upper chord member located between normally vertical planes passing through the normally lower chord members, and a longitudinally extending end support at each end of the structure.

8. A self-sustaining and load sustaining spanning structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members laterally spaced from each other and the upper chord members being located between normally vertical planes passing through the normally lower chord members, and a longitudinally extending end support at each end of the structure.

9. A self-sustaining and load sustaining spanning structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members located between normally vertical planes passing through the normally lower chord members, and a longitudinally extending end support at each end of the structure.

10. A self-sustaining and load sustaining spanning structure for use as a joist and the like, the structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and a normally upper chord member located between normally vertical planes passing through the normally lower chord members, longitudinally spaced laterally extending clamping bars operatively associated with some of the members, the clamping bars extending laterally beyond opposite sides of the normally upper chord member and being adapted to clamp tile and the like supported on the normally lower chord members, and a longitudinally extending end support at each end of the structure.

11. A self-sustaining and load sustaining spanning structure for use as a joist and the like, the structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members laterally spaced from each other and the upper chord members being located between normally vertical planes passing through the normally lower chord members, longitudinally spaced laterally extending clamping bars operatively associated with some of the members, the clamping bars extending laterally beyond opposite sides of the normally upper chord members and being adapted to clamp tile and the like supported on the normally lower chord members, and a longitudinally extending end support at each end of the structure.

12. A self-sustaining and load sustaining spanning structure for use as a joist and the like, the structure including transversely spaced longitudinally extending chord members, and truss means maintaining the chord members in load sustaining positions throughout the span length thereof, the chord members including normally lower chord members laterally spaced from each other and normally upper chord members located between normally vertical planes passing through the normally lower chord members, longitudinally spaced laterally extending clamping bars operatively associated with some of the members, the clamping bars extending laterally beyond opposite sides of the normally upper chord members and being adapted to clamp tile and the like supported on the normally lower chord members, and a longitudinally extending end support at each end of the structure.

13. A self-sustaining and load sustaining spanning structure including a normally upper longitudinally extending chord member and normally lower longitudinally extending chord members, and members interposed therebetween and maintaining the chord members in load sustaining relationship with each other throughout the span length thereof, the lower chord members being located in normally vertical planes spaced laterally from the normally vertical plane passing through the upper chord member, and longitudinally spaced laterally extending clamping members on the structure, the clamping members extending beyond opposite sides of the normally upper chord member.

HURXTHAL F. FREASE.