United States Patent

Atkinson

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[54] **STRUCTURAL CHORD MEMBERS FOR JOIST CONSTRUCTION**

[72] Inventor: **Archibald H. Atkinson,** 161 Terrence Park Dr., Ancaster, Ontario, Canada

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[52] **U.S. Cl.** **52/693,** 52/724, 52/732

[51] **Int. Cl.**.....**E04c 3/293**

[58] **Field of Search**.....52/693, 690, 694, 692, 691, 52/696, 697, 695, 634, 636, 725, 686, 376, 377, 724, 727, 722, 730, 732, 731

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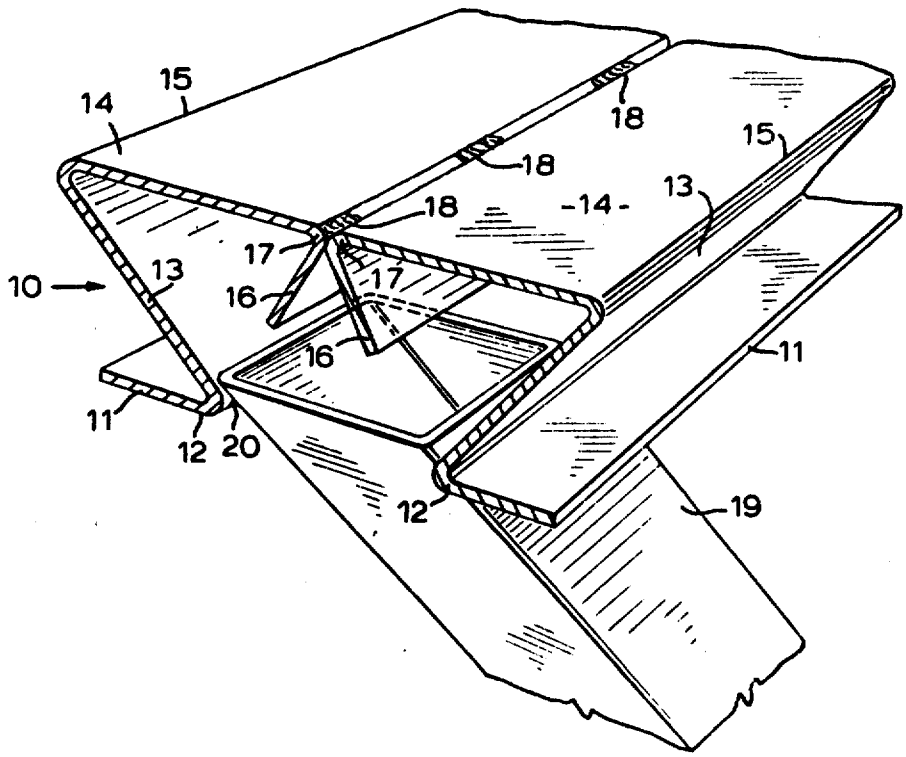
Primary Examiner—Frank L. Abbott
Assistant Examiner—Henry E. Raduazo
Attorney—Church and Rogers

[57] **ABSTRACT**

A new structural chord member is provided from which joists can readily be formed of different sizes and capabilities. Each chord member has a cross section represented by two modified Z-section members disposed with their top flanges coplanar and their chord webs inclined toward one another, the junctions between the chord webs and the bottom flanges being spaced apart for insertion of joist web members to form the joist member. Each chord member is provided with compositing shear projections extending from its top flanges alternatively away from or toward the chord member interior.

A particular joist construction comprises two spaced hollow chord members connected by a plurality of joist web members, the upper chord member being filled with high strength cementitious material to apply preloading tension to the lower chord member and increase the moment of inertia of the joist.

15 Claims, 9 Drawing Figures



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SHEET 1 OF 3

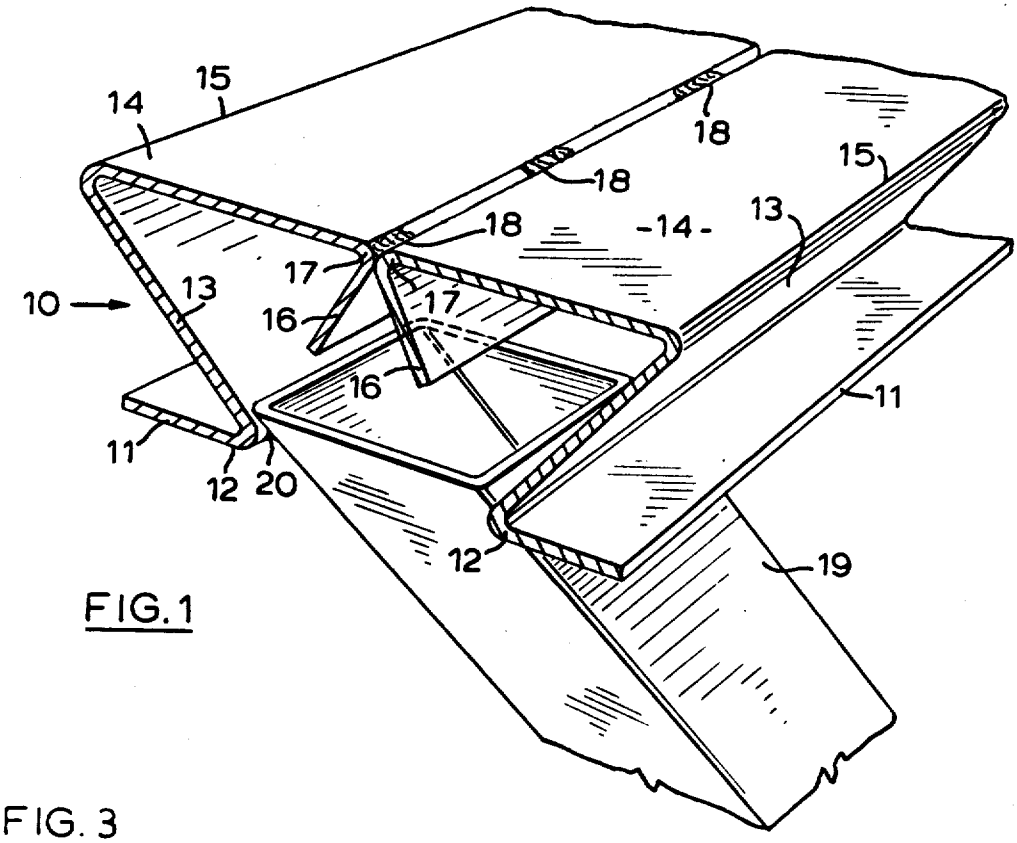


FIG. 1

FIG. 3

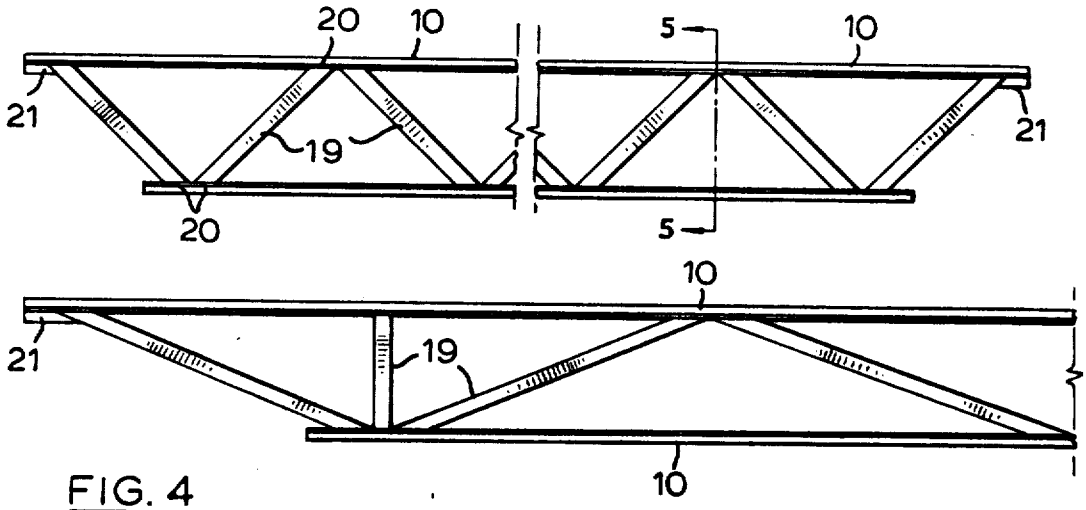


FIG. 4

INVENTOR.
ARCHIBALD H. ATKINSON
BY: Church and Rogers
PATENT AGENTS

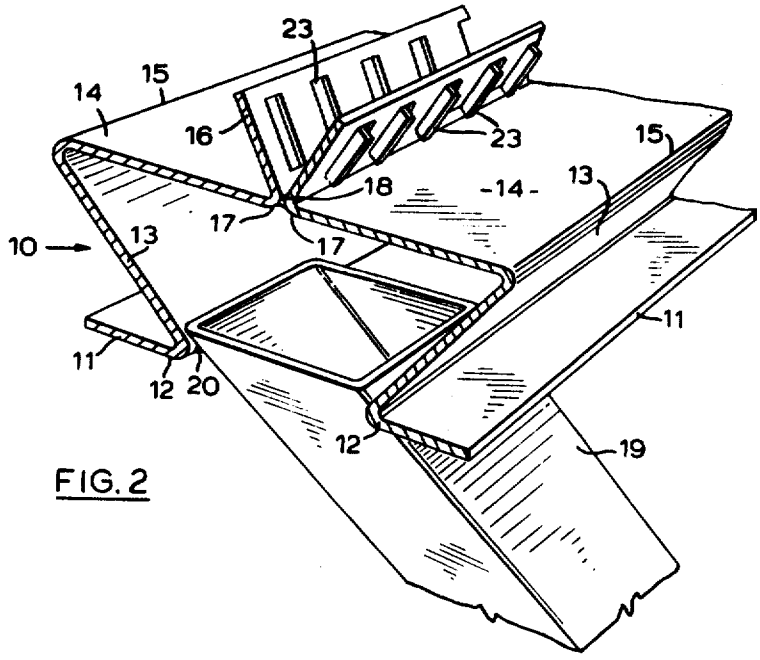


FIG. 2

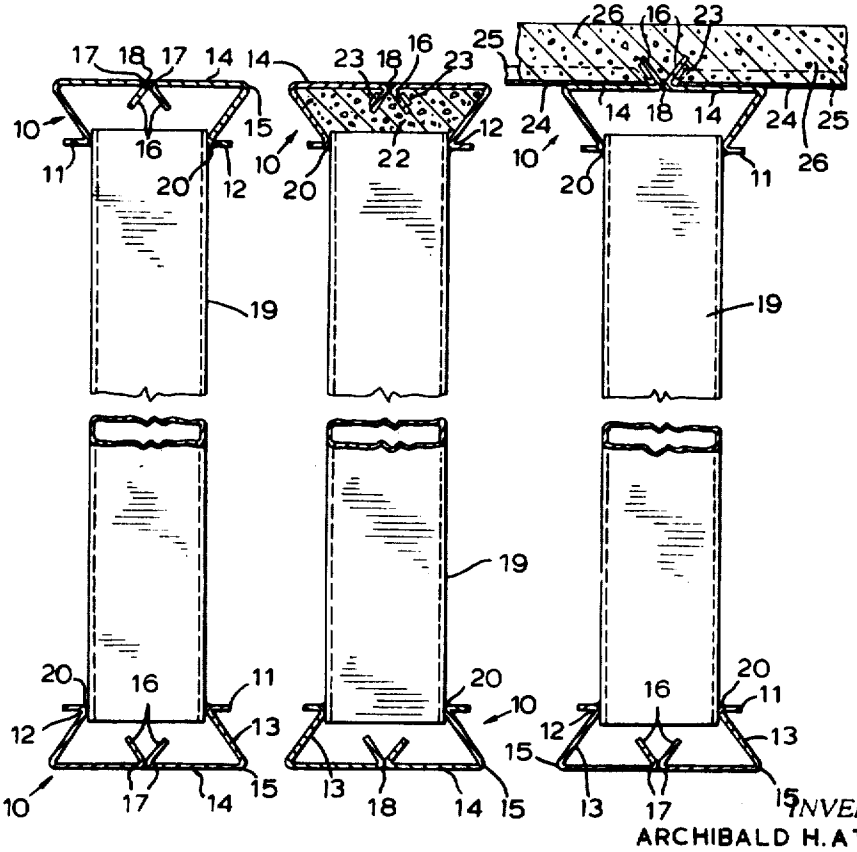


FIG. 5

FIG. 6

FIG. 7

INVENTOR.
ARCHIBALD H. ATKINSON

BY: Church and Rogers

PATENT AGENTS

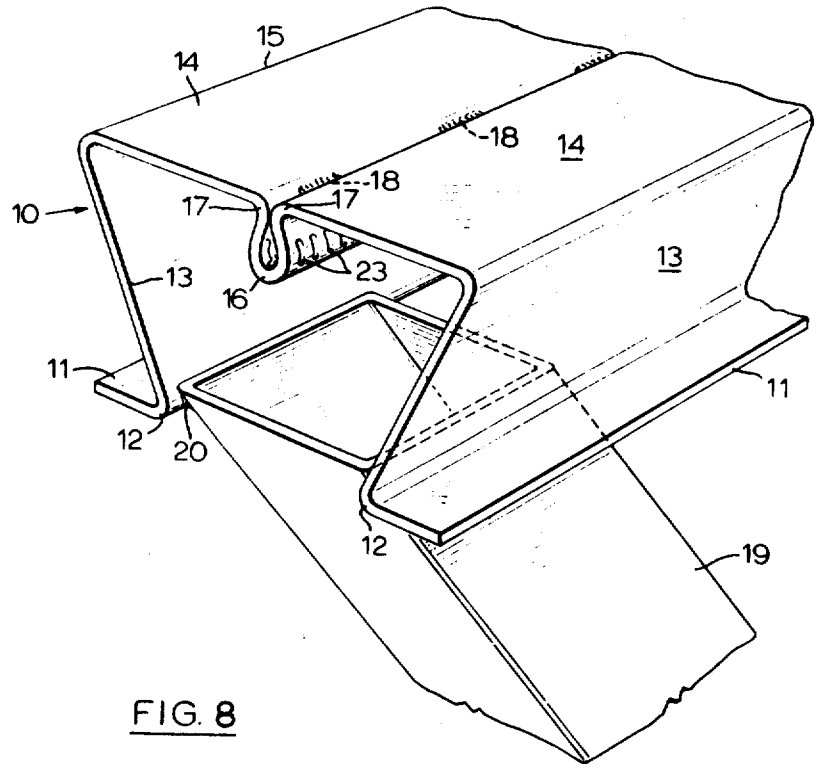


FIG. 8

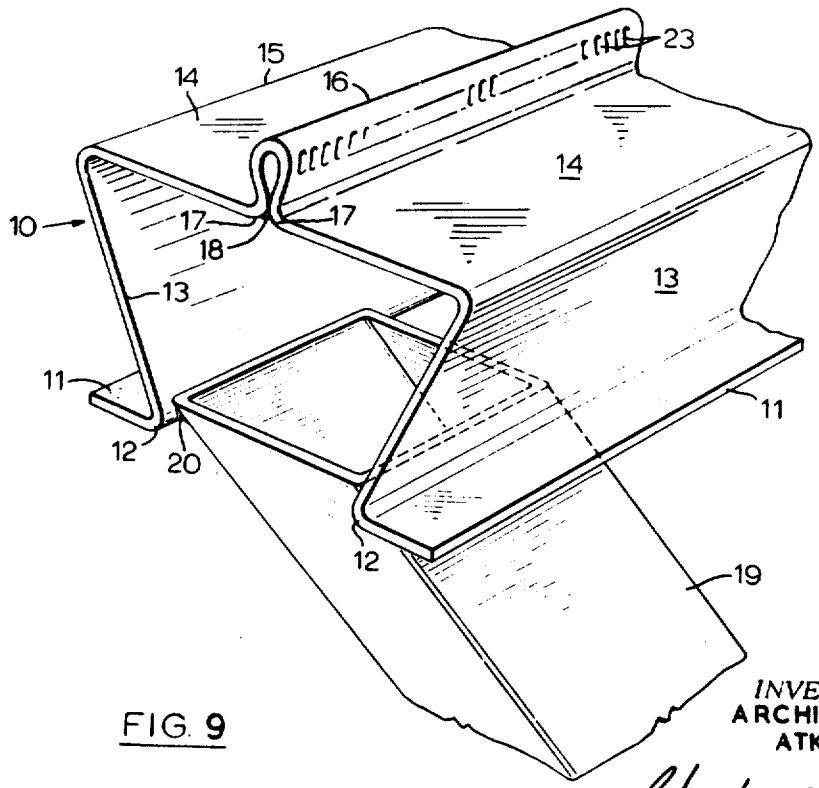


FIG. 9

INVENTOR.
ARCHIBALD H.
ATKINSON

BY: Church and Rogers

PATENT AGENTS

STRUCTURAL CHORD MEMBERS FOR JOIST CONSTRUCTION

FIELD OF THE INVENTION

The present invention relates to improvements in structural chord members of the kind adapted for the rapid and economical fabrication therefrom of joists of different sizes and structural capabilities, and to improvements in joists fabricated from such structural members.

DESCRIPTION OF THE PRIOR ART

It is known, for example, from U.S. Pat. specification Ser. No. 2,514,607, issued 11th July, 1950 to provide a truss construction wherein each of the upper and lower chord members is formed of a pair of opposed hot-rolled, right-angled Z-sections with the webs thereof parallel and the inwardly-turned flanges thereof connected, the two chord members being connected by structural sections fastened to gusset plates that are in turn fastened to the said parallel webs. It is also known from U.S. Pat. specification Ser. No. 2,097,722 issued Nov. 2, 1937 to provide a joist having tubular chord members that are filled with a nailable cementitious material, such as a mixture of 55 parts gypsum, 20 parts of portland cement and 9 parts of sawdust, all by weight.

SUMMARY OF THE INVENTION

It is a principal object of the invention to provide a new structural chord member.

It is another object to provide a new structural chord member especially adapted for the fabrication therefrom of joists of different sizes and capabilities.

It is a further object to provide a new joist construction.

In accordance with the present invention there is provided a structural chord member adapted for the fabrication of joists therefrom comprising a pair of connected, opposed modified "Z" section members, each member having a longitudinal shear projection, a top flange rigidly connected to the shear projection along a respective top member junction, a bottom flange and a chord web connecting the said top and bottom flanges, wherein the top flanges of the two members extend toward one another and are rigidly connected to one another at said top member junctions, wherein the chord webs are inclined toward one another from the top flange toward the bottom flange to provide a corresponding chord member cross-section of decreasing width, wherein the bottom junctions of each chord web with its respective bottom flange are spaced from one another for the insertion therebetween of a joist web member, and wherein the said shear projections project transversely to the top flanges.

Also in accordance with the present invention there is provided a structural chord member for the fabrication of joists therefrom comprising a top flange, two bottom flanges, and two chord webs each connecting the said top flange and a respective bottom flange, wherein the chord webs are inclined toward one another from the top flange toward the bottom flange to provide a corresponding chord member cross-section of decreasing width, wherein the bottom junctions of each chord web with its respective bottom flange are spaced from one another for the insertion therebetween of a joist web member, the member also comprising a shear projection rigidly connected to the top flange and constituted by a closed loop of material extending longitudinally thereof.

Further in accordance with the present invention there is provided a joist comprising two spaced structural chord members in accordance with the invention, the chord members being disposed spaced apart with their bottom flanges facing one another, and a plurality of joist web members connecting the chord members to form a joist member.

The purpose of the said shear projections is to ensure that full composite action is obtained between the metal of the joist members and concrete with which they are used in the formation of the typical building structure. The resulting structure in which the metal and cement co-operate effectively with one another is generally referred to in this particular art as a "composite" structure.

Further in accordance with the present invention there is provided a joist comprising two similar, spaced hollow chord members disposed parallel to one another, a plurality of joist web members each extending between and connected to the two chord members to connect them together and thereby form a joist, and a high strength cementitious material filling the interior of the upper chord member only to apply corresponding tensional stress to the lower chord member and to increase the moment of inertia of the joist.

DESCRIPTION OF THE DRAWINGS

Particular preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings wherein:

FIG. 1 is a perspective view of one end of a structural member in accordance with the invention to show the cross-section thereof, and to show the manner in which a web member is fastened thereto to form a joist,

FIG. 2 is a view similar to FIG. 1, but showing a structural member wherein shear projections project away from the interior of the member instead of into the interior thereof,

FIG. 3 is a side elevation of one form of joist incorporating the structural member of FIGS. 1 or 2,

FIG. 4 is a side elevation of another form of joist employing the structural member of FIGS. 1 or 2,

FIG. 5 is a plane cross-section taken on the line 5—5 of FIG. 3, employing the member of FIG. 1,

FIG. 6 is a plane cross-section through a new joist in accordance with the invention,

FIG. 7 is a similar cross-section through a joist illustrating its incorporation into a composite floor structure,

FIG. 8 is a view similar to FIG. 1 of another structural member in accordance with the invention, and

FIG. 9 is a view similar to FIG. 2 of another structural member in accordance with the invention.

Similar parts are given the same reference in all the figures of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now especially to FIGS. 1 and 2, a structural chord member illustrated therein is indicated by the reference 10, and is formed from two similar elements, which are defined herein for convenience in terminology as being of modified Z cross-section. The elements may readily be cold-rolled in any convenient size and length from high tensile, thin sheet steel strip of appropriate width, thickness and mechanical characteristics. The sheet steel employed should be of high yield strength, i.e. greater than 40,000 p.s.i., preferably in the range 50,000 to 60,000 p.s.i.

Each element comprises a bottom flange 11 having a bottom junction or corner 12 with a chord web 13, a top flange 14 having a junction or corner 15 with the web 13, and a shear projection 16 extending longitudinally of the member and having a junction 17 with the top flange 14, the top and bottom flanges, the chord web and the shear projection being integrally formed. In one embodiment illustrated by FIG. 1 each projection 16 projects downwards at an angle of about 60° from its respective top flange into the interior of the chord member. In other embodiments illustrated by FIG. 2 each projection projects at about the same angle of 60° to the top flange away from the interior of the chord member. The said shear projections may of course extend at other angles to their respective top flanges, but the said angle of about 60° is preferred, since with the two top flanges in their preferred coplanar configuration the two projections are inclined at about 60° to one another and have maximum effect in the compositing action which they provide.

The two top flanges 14 are turned inwardly with the junctions 17 abutting and, as described above, preferably are coplanar. The two elements are fastened rigidly together at the junctions 17 to form the chord member, preferably by means of welds indicated by the reference 18. The welds 18 preferably are applied by the use of automatic machinery and may be continuous or intermittent; when intermittent welds are employed the spaces between them may serve as nailing slots. The two chord webs 13 are inclined toward one another from the top flange toward the bottom flange to provide a corresponding truncated triangular cross-section of decreasing width, the bottom junctions 12 being spaced from one another. The angle between each bottom flange 11 and the chord web 13 is the same as that between the web and the top flange 14, so that the two associated bottom flanges 11 also are coplanar. The lateral extent of the flanges 11 is such that they do not extend beyond a vertical projection (as seen in FIGS. 5 to 7) from the respective junctions 15.

The structural chord member is accordance with the invention is employed to form a truss or joist member by disposing two lengths of the chord members in parallel relation to one another with their lower flanges 11 and the spaces therebetween facing one another; the required number of individual joist web members 19 are interposed between the said lengths with their ends inserted in the said spaces. The width of the joist members is substantially equal to the spacing of the opposed junctions 12 and they are fastened to the chord members at these junctions, preferably by means of welds indicated herein by the reference 20.

Preferably, as illustrated herein, the joist members 19 are of square cross-section and the individual members may be cut to the required length from a longer piece thereof. This construction employing individual members that project between the junctions 12 has a number of special advantages for economical fabrication of the joists. For example, the tolerance required in cutting the joist members is low since they will simply project slightly more or less into the interiors of the chord members; the cut ends do not require any finishing such as grinding to remove burrs; the joist sections can be supplied and stored in relatively long lengths which are cut as required, obviating the need for an expensive inventory of accurately preformed members that may or may not be required.

In the relatively short-span, small-depth joist illustrated in FIG. 3 (say from 8 inch to 18 inch depth and employed to support modules of 24 inch width) only diagonal joist members will usually be employed, while with the larger span, larger-depth joist illustrated by FIG. 4 (say of 18 inch depth and more and employed to support modules of 48 inch width and more) intermediate vertical members will also be employed. In both cases the ends of the upper chord members, by which the joists are supported on columns or walls etc., are provided in known manner with additional fillet pieces 21.

The resultant cross-section of the standard joist is illustrated herein by FIG. 5, wherein the said shear projections extend into the interiors of the chord members. In a particularly advantageous joist construction illustrated by FIG. 6 the interior of the upper chord member only is filled with a high strength cementitious material 22 which is rigidly connected to the material of the chord section for composite action therewith by the compositing projections 16, and also by the decreasing width cross-section of the chord member. One action of the cementitious material is to preload the joist in a designed manner and enable reduced deflection to be obtained under the loads to which the joist is subjected. Another action is to increase the moment of inertia of the joist and thereby permit the ready utilization of thin, high-strength steels for their production. The material employed may for example be portland cement or cement fondue and must be of high strength, i.e. having a compressive strength greater than 5,000 p.s.i. and preferably in the range 6,000–12,000 p.s.i.; the material should also have as small a shrinkage characteristic as possible so that it maintains close contact with the hollow metal chord member to maintain the said composite action.

In order to increase the adherence and composite action keying between the chord member and the material 22, the projections 16 may be provided with deformations 23 extending out of the general plane of each projection. In the embodiment of FIG. 2 these deformations are illustrated as being portions struck out from the respective projection 16, but other forms may be employed, for examples corrugations and dimples.

The embodiment illustrated by FIG. 7 is intended for use in a composite cast floor structure. The lower chord member has the form shown in solid lines in FIG. 1, while the upper chord member has the alternative structure shown by FIG. 1, wherein the projections 16 extend away from the chord member interior. The

upper chord member supports on the upper flanges **14** respective layers **24** of deck material having vertically extending keying members **25**. A layer **26** of cement is applied over the deck material and encloses the projections **16** with their deformations **23** and the members **25** of the deck **24** to provide a floor structure that is completely compositely connected with its supporting joists.

In the embodiment illustrated by FIGS. **8** and **9** the two opposed modified Z-section members are connected by being formed integrally with one another. Such an embodiment can be manufactured as a completely integral member by rolling from a strip of appropriate width, the longitudinally-extending shear projection **16** being constituted by folding the central portion of the strip to the form of a loop extending transversely out of the plane of the top flange. Preferably, as illustrated, the form of the loop is such that the junctions **17** are immediately adjacent to one another and are joined directly together by the welds **18**. As with the embodiment of FIGS. **1** and **2** the shear projection can extend into the interior of the chord member, illustrated by FIG. **8**, or upwards from the top flange away from the interior illustrated by FIG. **9**. Preferably it is provided with deformations **23**, constituted for example by corrugations formed by the rolling operation.

What I claim is:

1. A structural chord member adapted for the fabrication of joists therefrom comprising a pair of connected, opposed modified Z-section members, each member having a longitudinal shear projection, a top flange rigidly connected to the shear projection along a respective top member junction, a bottom flange and a chord web connecting the said top and bottom flanges, wherein the top flanges of the two members extend toward one another and are rigidly connected to one another at said top member junctions, wherein the chord webs are inclined toward one another from the top flange toward the bottom flange to provide a corresponding chord member cross-section of decreasing width, wherein the bottom junctions of each chord web with its respective bottom flange are spaced from one another for the insertion therebetween of a joist web member, and wherein the said shear projections project transversely to the top flanges.

2. The invention as claimed in claim **1**, wherein each Z-section member is rolled from sheet steel material to have the said top and bottom flanges, the said chord web and the said shear projection integral with one another.

3. The invention as claimed in claim **1**, wherein each said shear projection projects at about 60° to the respective top flange and the two projections are inclined at about 60° to one another.

4. The invention as claimed in claim **1**, wherein the shear projections project from the said top member junctions into the interior of the chord member.

5. The invention as claimed in claim **1**, wherein the shear projections project from the said top member junctions away from the interior of the chord member.

6. The invention as claimed in claim **1**, and comprising two spaced structural chord members disposed spaced apart with their bottom flanges facing one another, and a plurality of joist web members each inserted at each end between the two bottom flanges of the corresponding chord member and fastened to the chord members to connect them and thereby form a joist member.

7. The invention as claimed in claim **1**, and comprising two spaced structural chord members disposed spaced apart with their bottom flanges facing one another, and a plurality of joist web members connecting the chord members to form a joist, and wherein the upper chord member only is filled with a high strength cementitious material to apply corresponding tensional stress to the lower chord member and to increase the moment of inertia of the joist.

8. The invention as claimed in claim **1**, and comprising two spaced structural chord members disposed spaced apart with their bottom flanges facing one another, and a plurality of joist web members connecting the chord members to form a joist member, wherein the upper chord member only is filled with a high strength cementitious material to apply corresponding tensional stress to the lower chord member and to increase the moment of inertia of the joist, and wherein the upper chord member has the respective shear projections projecting into its interior to be enclosed by the cementitious material.

9. The invention as claimed in claim **1**, and comprising two spaced structural chord members disposed spaced apart with their bottom flanges facing one another, and a plurality of joist web members each inserted at each end between the two bottom flanges of the corresponding chord member and fastened to the chord members to connect them and thereby form a joist member, wherein the upper chord member has the shear projections projecting from the top flanges away from the interior of the chord member, and the lower chord member has the shear projections projecting from the top flanges into the interior of the chord member.

10. A structural chord member for the fabrication of joists therefrom comprising a top flange, two bottom flanges and two chord webs each connecting the said top flange and a respective bottom flange, wherein the chord webs are inclined toward one another from the top flange toward the bottom flange to provide a corresponding chord member cross-section of decreasing width, wherein the bottom junctions of each chord web with its respective bottom flange are spaced from one another for the insertion therebetween of a joist web member, the member also comprising a shear projection rigidly connected to the top flange and constituted by a closed loop of material extending longitudinally thereof.

11. The invention as claimed in claim **10**, wherein the said closed loop shear projection is constituted by a portion of the sheet steel material rolled to the form of a loop, the top flange, bottom flanges, chord web and projection all being integral with one another.

12. The invention as claimed in claim **10**, wherein the junctions of the said closed loop projection with the top flange are disposed immediately adjacent to one another and are joined directly to one another.

13. The invention as claimed in claim **10**, and comprising two spaced structural chord members disposed spaced apart with their bottom flanges facing one another, and a plurality of joist web members each in-

serted at each end between the two bottom flanges of the corresponding chord member and fastened to the chord members to connect them and thereby form a joist member.

14. The invention as claimed in claim 10, and comprising two spaced structural chord members disposed spaced apart with their bottom flanges facing one another, and a plurality of joist web members connecting the chord members to form a joist, wherein the upper chord member only is filled with a high strength cementitious material to apply corresponding tensional stress to the lower chord member and to increase the moment of inertia of the joist.

15. The invention as claimed in claim 1, wherein the upper chord member is provided with at least one respective shear projection rigidly fastened thereto and projecting into its interior to be enclosed by the cementitious material.

* * * * *