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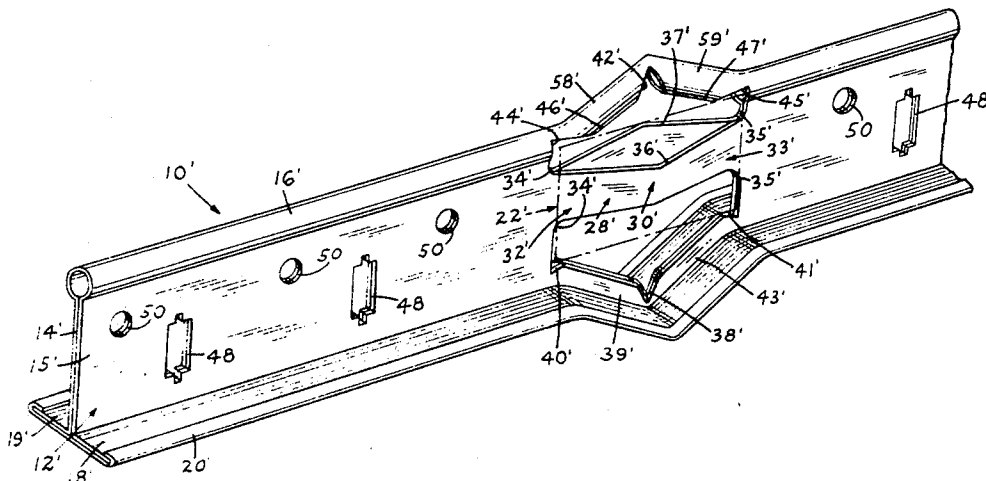
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[54] **STRUCTURAL BEAM FOR CEILING SUSPENSION SYSTEM**  
**10 Claims, 5 Drawing Figs.**

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**52/495, 52/573, 52/DIG. 5**  
 [51] Int. Cl. .... **E04c 2/42,**  
**E04b 1/98**  
 [50] Field of Search ..... **52/232,**  
**573, DIG. 5, 495**

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**ABSTRACT:** A structural beam member comprising a pair of elongated metal strips disposed in side-by-side abutting relationship to form an upstanding web, an elongated rib joining the top of the strips, and an elongated flange extending laterally from each side of the base of the web, so that the beam has substantially an inverted tee cross section. The web portion includes an expansion relief space of generally rectangular configuration. The margins of the expansion relief space, parallel to the longitudinal axes of the flange and rib portions, have opposed cutout triangular notches extending into the web and rib portions. A strap of the web portion longitudinally spans the expansion relief space. The width of the web strap tapers inwardly from both ends so that the web strap is narrowest at its middle.



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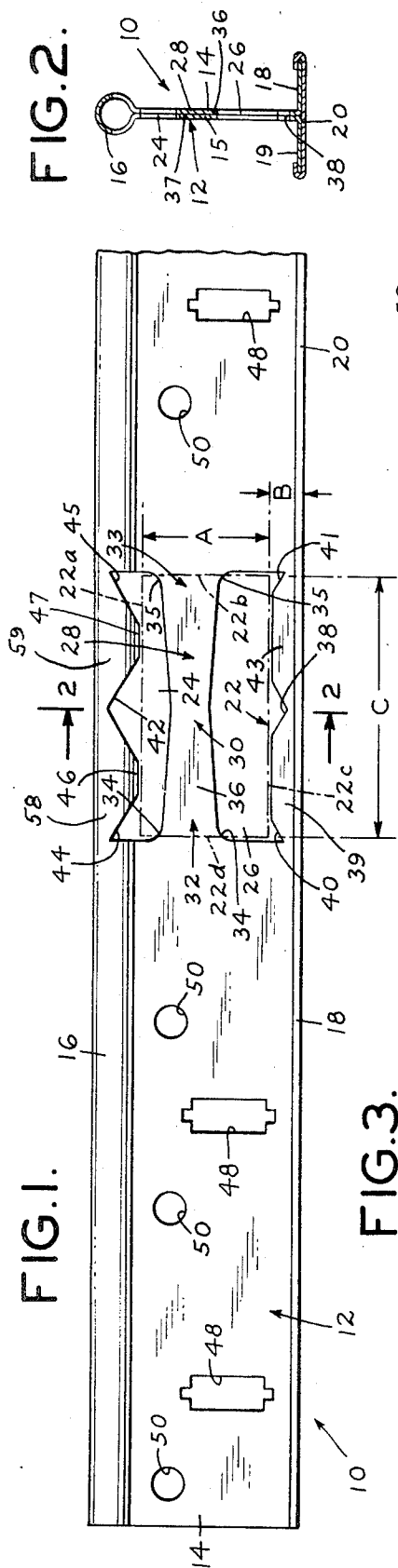
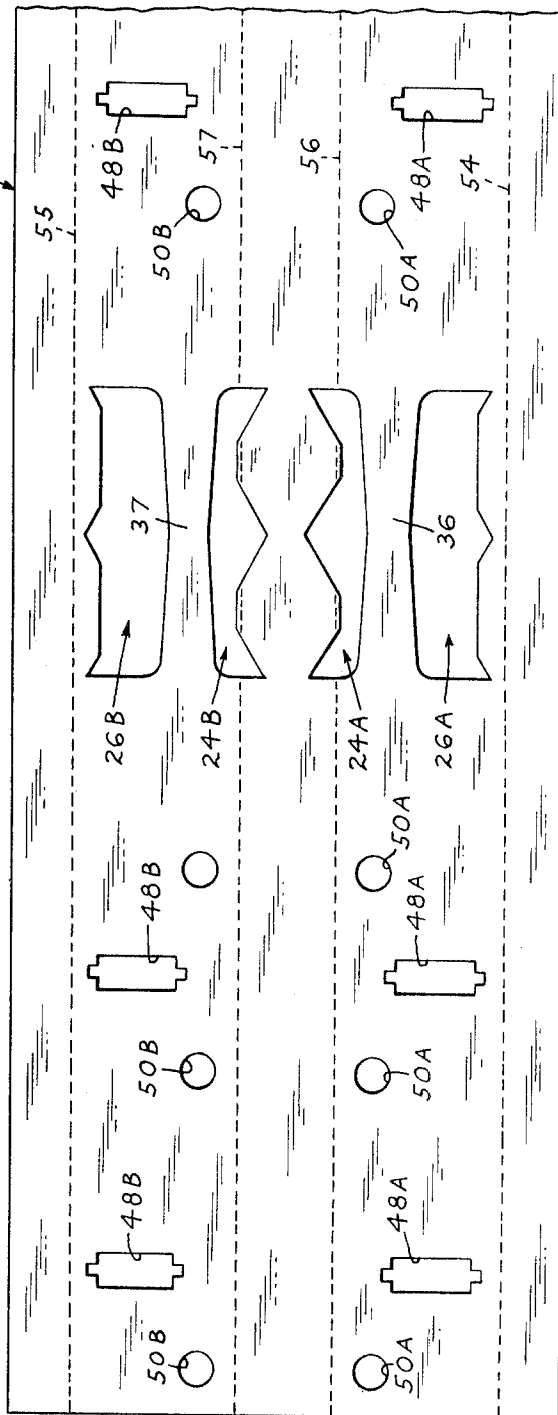
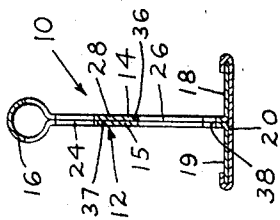


FIG. 3.



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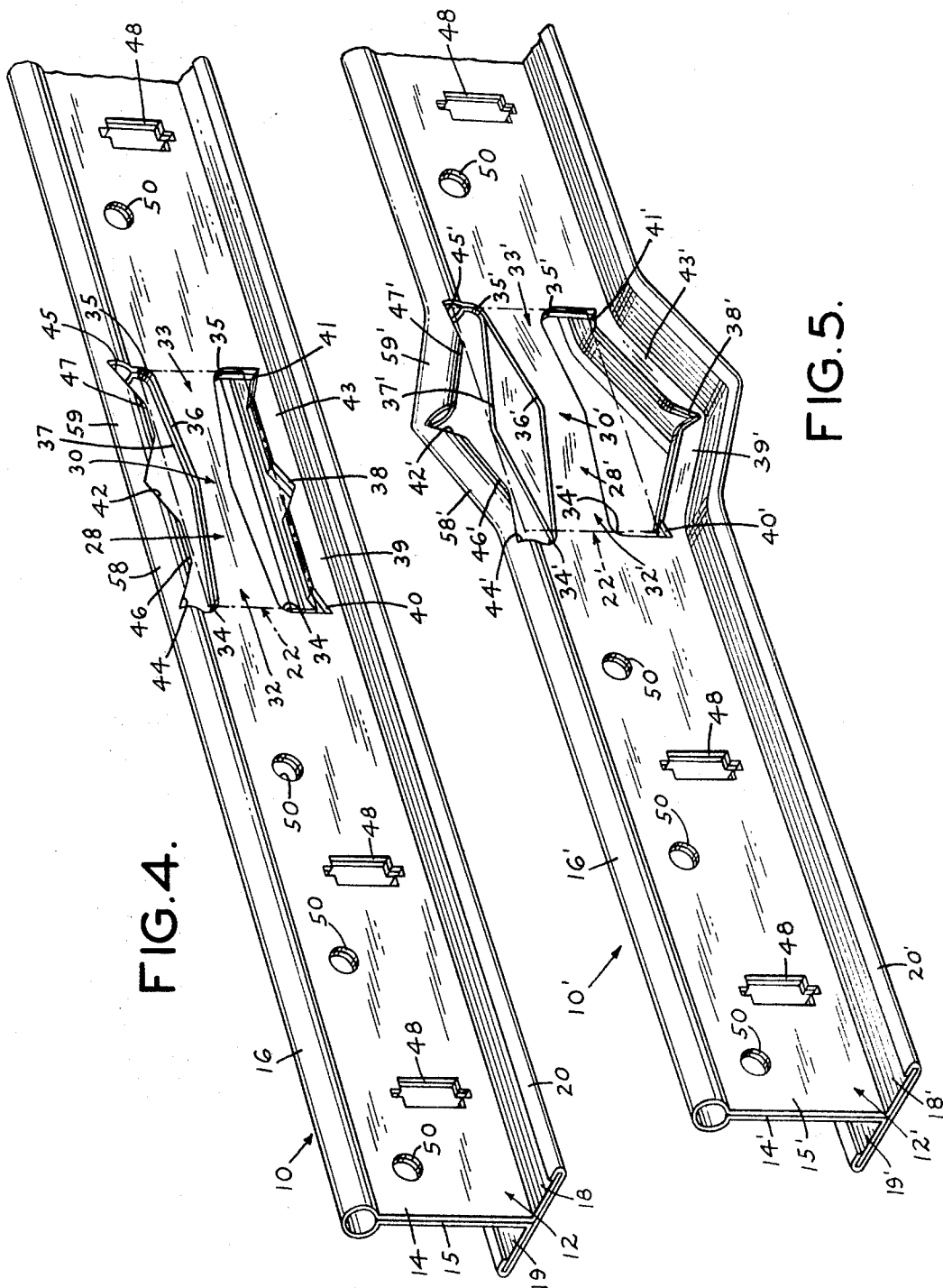


FIG. 4.

FIG. 5.

## STRUCTURAL BEAM FOR CEILING SUSPENSION SYSTEM

### BACKGROUND OF THE INVENTION

The present invention relates to a structural beam member characterized by means for isolating thermal expansion deformation to a particular portion of the beam. More particularly the present invention relates to structural beams used in suspended ceiling constructions in which a metallic grid system is suspended from primary ceiling members and used to support acoustical tiles or other ceiling panels.

In recent years it has been common in the construction of new buildings and in the renovation of old buildings to employ suspended ceilings in which acoustical tiles or other types of panels are supported by flanged beams, usually made of steel or aluminum. In most such systems the flanged beams are arranged in a rectangular grid system with long parallel beams, called "main runners," being joined at suitable intervals by transverse parallel beams called "cross T's." In some systems the bottom flange of the metal beams forms a part of the visible ceiling surface while in others the metal beams are not visible after the ceiling panels are installed.

When the metal beams of a ceiling suspension system are subjected to high temperatures which accompany fires, the metallic beams undergo a considerable increase in length. Unless means are provided for absorbing the increase in length due to thermal expansion, long structural members tend to bend and twist, dropping the ceiling panels on to the floor beneath. Thus, even though these ceiling panels may be highly resistant to fire conditions, much of the fire-retarding advantage of such panels is lost when some or all of the panels fall due to twisting of the suspension system. In many cases, twisting of the beam in a direction transverse of its length but in the plane of the ceiling may actually break the ceiling panels.

The present invention provides a structural beam member characterized in that under exposure to extremely high temperatures, longitudinal expansion is controlled and isolated to a particular point in the beam where the expansion is accommodated without twisting of the beam. This is accomplished by cutting away portions of the beam at the point where it is desired to localize the expansion of the beam. The shape of this cutout portion is designed so as to minimize the weakening of the beam at this point and yet provide for controlled distortion of the beam during thermal expansion. Additional features of the construction of the present invention are a relatively simple design and economical manufacture and installation.

A preferred embodiment of the present invention comprises a pair of elongated metal strips disposed in side by side abutting relationship to form an upstanding web, an elongated rib joining the top of the strips, and an elongated flange extending laterally from each side of the base of the web, so that the beam has substantially an inverted tee cross section. The web portion includes an expansion relief space of generally rectangular configuration. The margins of the expansion relief space, parallel to the longitudinal axes of the flange and rib portions, have opposed cutout triangular notches extending into the web and rib portions. The notches along the expansion space margin nearest the flange portion do not extend to the plane of the upper surface of the flange portion; thus there is a narrow portion of the web structure at all points between the edge of the expansion relief space and upper surface of the flange. This narrow portion of the web adds to the supportive strength of the beam without significantly interfering with the controlled deformation of the beam on thermal expansion.

A strap of the web portion longitudinally bridges the expansion relief space. The width of the web strap tapers inwardly from both ends so that the web strap is narrowest at its middle. This tapered design insures that the web strap will buckle at its midpoint and deform in a plane parallel to the plane of the flange on thermal expansion.

### SUMMARY OF THE INVENTION

A structural beam member comprising a pair of elongated metal strips disposed in side by side abutting relationship to form an upstanding web, an elongated rib joining the top of the strips, and an elongated flange extending laterally from each side of the base of the web, so that the beam has substantially an inverted tee cross section.

The web portion includes an expansion relief space of generally rectangular configuration. The margin of the expansion relief space, parallel to the longitudinal axes of the flange and rib portions, have opposed cutout triangular notches extending into the web and rib portions. The notches along the expansion space margin nearest the flange portion extend to a point above the plane of the upper surface of the flange portion; there is some portion of the web structure at all points between the edge of the expansion relief space and the flange.

A strap of the web portion longitudinally spans the expansion relief space. The width of the web strap tapers inwardly from both ends so that the web strap is narrowest at its middle to insure that the web strap will buckle at its midpoint on thermal expansion.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view illustrating one form of beam construction in accordance with the invention;

FIG. 2 is a cross-sectional view taken along the line 2-2 of FIG. 1;

FIG. 3 is a bottom plan view of a length of sheet metal illustrating a preblanking operation in the formation of the beam of FIG. 1;

FIG. 4 is a perspective view of the beam of FIG. 1;

FIG. 5 is a perspective view of the beam of FIG. 1 after deformation due to thermal expansion.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and more particularly to FIGS. 1, 2 and 4, there is illustrated a typical suspended ceiling beam 10 embodying the invention. It could be used as either a main runner or cross tee, although usually it will be a main runner. The beam 10 is normally formed from relatively thin cold-rolled steel and is comprised of an upstanding web 12 formed from vertical portions 14 and 15 joined at the top by a rounded or bulbous rib 16. In other embodiments the rib 16 is of rectangular configuration. The web portions 14 and 15 are provided with outwardly extending, panel supporting flanges 18 and 19, respectively. As best shown in FIG. 2, the beam in cross section has essentially an inverted tee shape. A decorative flange cover 20 caps the flanges 18 and 19 to provide an attractive under surface for installations where it is a visible part of the installed ceilings.

Only a short length of the beam 10 is shown in the drawings. In the case of a main runner, the beam 10 might typically be 8 or 12 feet long, while in the case of a cross tee, beam 10 might typically be 2 or 4 feet long.

The web 12 of the beam 10 is provided with a longitudinally extending cutout portion which may be termed an expansion relief space or rout 22. The expansion relief rout 22 is of a generally rectangular shape. In FIG. 1 the lines 22a, 22b, 22c, and 22d form an illustrative rectangular border for the expansion relief rout 22. The line 22a runs parallel to, and is located nearly adjacent to the top margin of the vertical portion 14 of the web 12. The line 22c is parallel to, and is located a distance A from the line 22a and a distance B from the bottom of the flange 18. Lines 22b and 22d are perpendicular to, and intersect lines 22a and 22b, respectively, and are a distance C apart. The axial dimension C is dependent upon the coefficient of expansion of the beam metal, upon the length of the beam, upon the number of relief sections to be provided in the beam and upon the maximum temperature to be accommodated. For purposes of illustration the lines 22a-22d are not shown in FIG. 1 as coinciding with the margins of the expansion relief rout 22, however, the dimensions A B and C are

based on the actual margins of the expansion relief space 22 of the embodiment of the drawings. For a 12 foot length of beam 1½ inches high, the distance A might typically be 0.970 inches, the distance B might typically be 0.265 inches, and the distance C might typically be 2,000 inches. The typical 12-foot beam of the embodiment shown in the drawings has one such expansion relief rout 22 spaced near a beam end. The vertical center of the expansion relief rout 22 (shown as line 2-2 in FIG. 1) is located 6 inches from one end of the beam 10.

Within the expansion relief rout 22, a portion 24 of the web 12 near the rib 16 is cut out. A portion 26 of the web 12 near the flanges 18 and 19 is also cut out, leaving a web strap 28 which horizontally spans the expansion relief rout 22 between the cutout portions 24 and 26. The web strap 28 is narrowest at its center 30 and has an outward taper toward both ends 32 and 33 which are bounded by the lines 22d and 22b, respectively. This tapered design insures that the web strap will buckle at its midpoint on thermal expansion. The web strap ends 32 and 33 have fillets 34 and 35, respectively, joining the web strap 28 to the web 12. The web strap 28 is comprised of two side by side portions 36 and 37 which are formed from the vertical portions 14 and 15, respectively.

A vee-shaped notch 38 extends from the reference line 22c into the web 12, with its vertex directed toward, but not reaching, the flanges 18 and 19. The notch 38 is located directly opposite the web strap center point 30. The angular opening of the notch 38 might typically be 120°.

A pair of right-triangular notches 40 and 41 also extend from the reference line 22c into the web 12 toward, but not touching, the flanges 18 and 19. The right angle of the notch 40 is located approximately at the intersection of the lines 22c and 22d. One margin of the notch 40 is parallel to the line 22d and the other margin forming the hypotenuse might typically be at 30° to the line 22c. The right angle of the notch 41 is located approximately at the intersection of the lines 22b and 22c. One margin of the notch 41 is parallel to the line 22b and the other margin forming the hypotenuse might typically be at 30° to the line 22c. A small portion 39 of the web 12 remains between the notches 38 and 40. Likewise, a small portion 43 of the web 12 remains between the notches 38 and 41. These web portions 39 and 43 add to the supportive strength of the beam 10.

A vee-shaped notch 42 is cut out of the web 12 and the rib 16 directly opposite the notch 38. The notch 42 extends from the line 22a through approximately five-eighths of the rib 16. The angular opening of the notch 42 might typically be 120°. A pair of right-triangular notches 44 and 45 also extend from the reference line 22a into the web 12 and the rib 16. The right angle of the notch 44 is located approximately at the intersection of the lines 22a and 22d. One margin of the notch 44 is parallel to the line 22d and the other margin forming the hypotenuse might typically be at 30° to the line 22a. The right angle of the notch 45 is located approximately at the intersection of the lines 22a and 22b. One margin of the notch 45 is parallel to the line 22b and the other margin forming the hypotenuse might typically be at 30° to the line 22a.

The notches 44 and 45 extend approximately halfway through the rib 16. A small portion 46 of the web 12 and a portion 58 of the rib 16 remain between the notches 42 and 44. Likewise, a small portion 47 of the web 12 and a portion 59 of the rib 16 remain between the notches 42 and 45. The web portions 46 and 47 add to the structural integrity of the beam 10 in normal use.

The web 12 is provided with generally rectangular routes 48 spaced periodically along the beam 10 which engage cross tee members. The web 12 is also provided with holes 50 to accommodate the wires usually used for suspending the beam 10 from the ceiling joists or other primary supports.

Referring now to FIG. 3, the beam 10 is shown in developed form, i.e., as a flat sheet of metal 52, and hence FIG. 3 represents the beam stock before rolling. The lines 54 and 55 represent the locations of the lines of intersection between the

flange 18 and the vertical web portion 14 and between the flange 19 and the vertical web portion 15, respectively. The lines 56 and 57 represent the upper margins of the vertical web portions 14 and 15, respectively.

The cutout portions 24A and 24B are aligned when the beam 10 is rolled to form the cutout space 24. The cutout portions 26A and 26B are aligned when the beam 10 is rolled to form the cutout space 26. Likewise, the cutout portions 48A, 48B, and 50A, 50B are aligned when the beam 10 is rolled to form the rectangular routes 48 and the holes 50, respectively. In other embodiments the beam 10 is first rolled from a plain sheet of metal to have a tee cross section and then the various holes, notches and expansion relief spaces are stamped out. In still other embodiments of the present invention the beam 10 is extruded as a solid piece in a tee cross section. The various routs, holes, notches, and expansion relief spaces discussed above are then cut out of the beam.

Referring now to FIG. 5 the beam 10' is illustrated after exposure to fire conditions. High temperatures expand the beam 10' longitudinally, and because its ends are restrained by the building walls or by abutting beams, the beam 10' acts as though a compressive, longitudinal force had been applied. This results in a shortening of the length of the expansion relief space 22'. Because the web strap 28' is tapered toward the middle, the vertical portions 36' and 37', of which it is comprised, buckle outward away from the plane of the web 12'. Although the vertical portions 36' and 37' are shown as buckled in opposite directions the controlled expansion will be achieved equally as well if they buckle together in the same direction. The strap will normally be above the tops of the supported ceiling tiles.

The expansion forces in the flanges 18' and 19' and in the vertical portions 14' and 15' will produce bending in the weakest portions in preference to stiffer portions. The notch 38' is the weakest part in the lower portion of the beam 10' and hence the expansion forces tend to close the vee-shaped notch 38'. This is illustrated in FIG. 5 where the vee-shaped notch 38' has a decreased angular opening. This decrease in the angular opening is produced by the downward deformation of the web portions 39' and 43' and the adjacent flange portions. The deformation also results in an expansion of the angular openings of the notches 40' and 41'.

Likewise, the weakest spot of the upper portion of the beam 10' is the notch 42'. Upon longitudinal thermal expansion the angular opening of the notch 42' decreases. This results from the upward deformation of the rib portions 58' and 59' and the associated web portions 46' and 47'. The deformation also increases the angular openings of the notches 44' and 45'. The resulting beam distortion thus takes place at a predetermined point in the beam and in the horizontal and vertical planes, without radical twisting of the beam, so that the ceiling panels do not break or drop from lack of support.

While the invention has been described in connection with specific embodiments thereof and in specific uses, various modifications thereof will occur to those skilled in the art without departing from the spirit and scope of the invention as set forth in the appended claims.

What I claim is:

1. A beam for use in a fire-retarding structural system, comprising a rib portion, a horizontal flange portion, and an up-standing web portion which joins the rib portion to the flange portion, the web portion having an opening forming an expansion relief space, the space being positioned intermediate the ends of the beam, the expansion relief space having a length taken along the length of the beam selected to accommodate anticipated axial expansion of the web portion upon exposure to a fire to thereby prevent twisting of such web portion and the expansion relief space including an upper and a lower margin, the web portion having triangular notches extending from the lower margin to a point above the flange portion, the web and the rib portion having triangular notches extending from the upper margin of the expansion relief space, the expansion relief space having a web strap which bridges the expansion

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relief space, the web strap having an inward taper such that it is narrowest at its middle, whereby the flange portion buckles downwardly, the rib portion buckles upwardly, and the web strap buckles outwardly when the beam is exposed to fire.

2. A beam for use in a fire-retarding structural system comprising a rib portion, an elongated flange portion, and an upstanding web portion joining the flange and rib portions, the web portion including an opening forming a generally rectangular expansion relief space, the expansion relief space having a first margin parallel to the longitudinal axis of the flange portion and located near the flange portion and a second margin parallel to the longitudinal axis of the rib portion and located near the rib portion, the first and second margins having opposed cutout triangular notches extending into the web and rib portions, the web having a strap portion longitudinally spanning the relief space, the width of the strap tapering inwardly from both ends such that said strap is narrowest at its middle.

3. A beam as set forth in claim 2 including fillets for joining the strap portion to the web portion.

4. A beam as set forth in claim 2 in which a pair of the opposed notches are vee shaped and longitudinally centered along the first and second margins of the expansion relief space.

5. A beam as set forth in claim 4 in which the notches extending from the first margin extend toward the flange portion to a point above the flange portion.

6. A structural beam member comprising a pair of elongated metal strips disposed in side by side abutting relation-

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ship to form an upstanding web, an elongated rib joining the top of the strips, and an elongated flange extending laterally from each side of the base of the web, the web portion including an opening of a generally rectangular configuration forming an expansion relief space, the expansion relief space having a first margin parallel to the longitudinal axis of the rib portion and a second margin parallel to the longitudinal axis of the flange portion, the first and second margins having cutout triangular notches extending into the rib and web portions, a strap of the web portion longitudinally spanning the expansion relief space, the width of the strap tapering inwardly from both ends such that the strap is narrowest at its middle, whereby the flange portion buckles downwardly, the rib portion buckles upwardly, and the strap buckles outwardly when the beam is exposed to fire.

7. A beam as set forth in claim 6 in which a pair of the notches are vee shaped and located opposite each other at the longitudinal center of the expansion relief space.

8. A beam as set forth in claim 6 in which the expansion relief space has four corners, the margins of the expansion relief space at each corner forming an acute angle.

9. A beam as set forth in claim 6 in which a portion of the web exists at all points between the notches extending from the lower margin of the expansion relief space and the flange portion.

10. A beam as set forth in claim 6 including fillets for joining the ends of the strap to the web portion.

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