Aug. 1, 1967 M. D. JAHN ETAL 3,333,378

RUNNER SYSTEM FOR FIRE-RESISTANT SUSPENDED CEILINGS

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Fig. 1

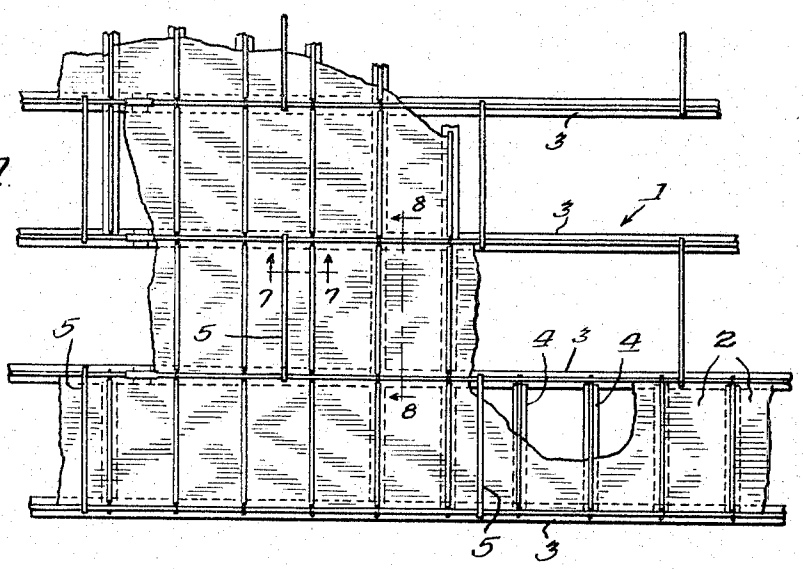


Fig. 2

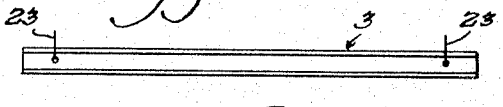


Fig. 3

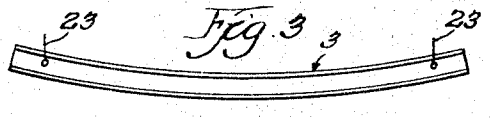


Fig. 4

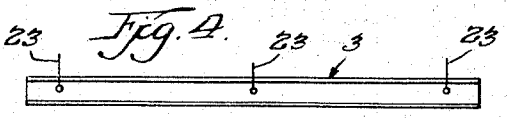


Fig. 5

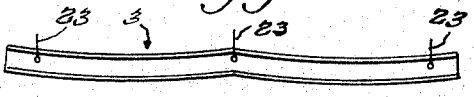


Fig. 6

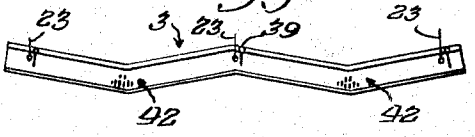
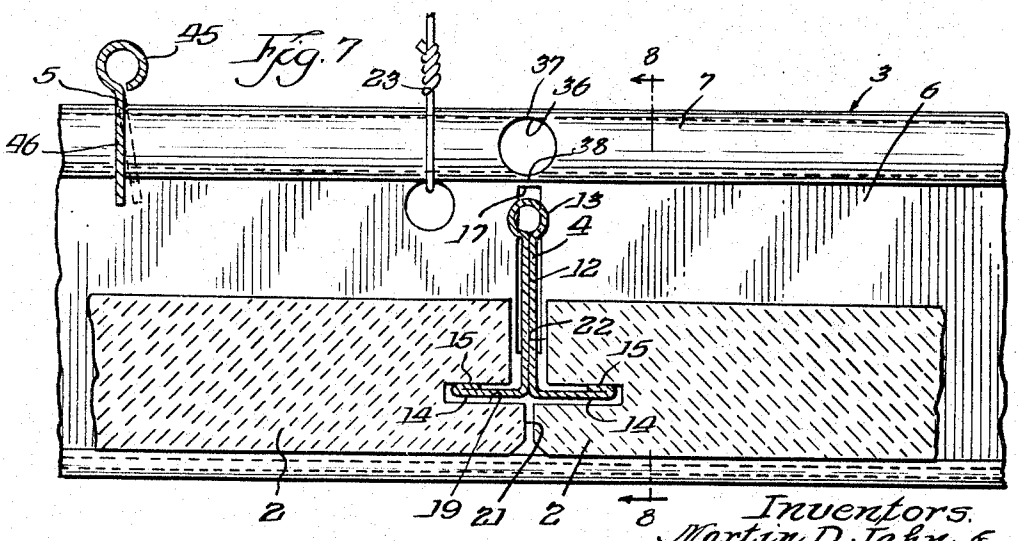


Fig. 7



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Fig. 8.

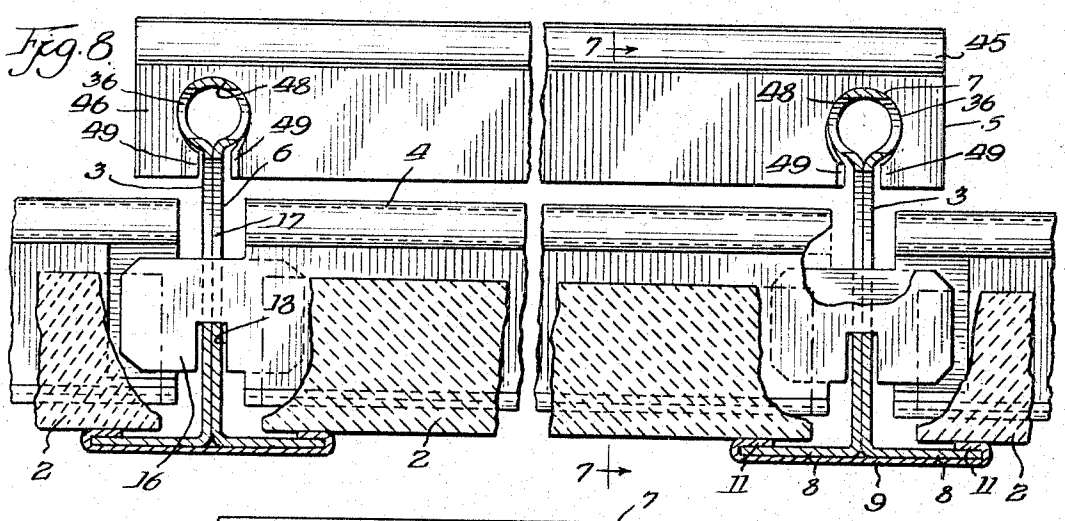


Fig. 9.

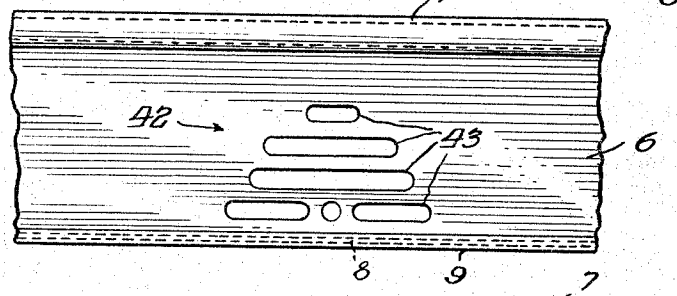


Fig. 10.

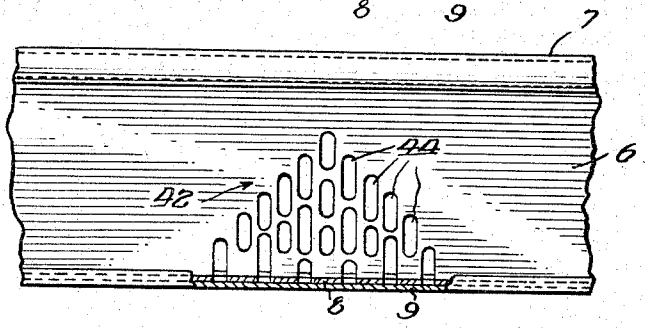
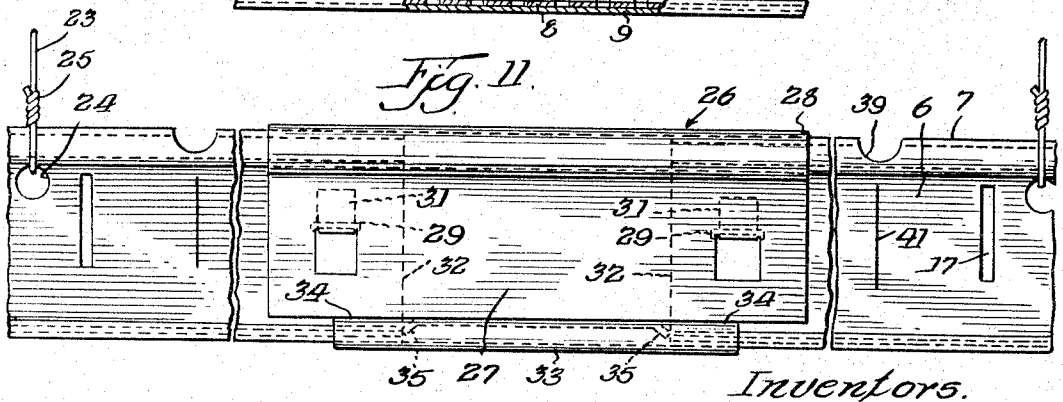


Fig. 11.



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RUNNER SYSTEM FOR FIRE-RESISTANT SUSPENDED CEILINGS

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8 Claims. (Cl. 52—232)

The invention relates generally to suspended ceiling structures for supporting acoustical tile ceiling panels and the like, and more particularly to a suspended ceiling structure which is fire resistant.

Tests have shown that suspended ceiling structures embodying mineral tile panels provide protection against the passage of flame and transmission of heat therethrough, the degree of such protection generally being dependent upon the ability of the structure to sufficiently limit buckling of the elements comprising the same whereby passage of flame and transmission of heat therethrough is satisfactorily retarded. In the case of concealed supporting structures wherein the metal runners are completely concealed, with the supporting elements lying in grooves in the tile members, and thus protected from direct application of heat thereto, the problem of buckling of the ceiling structure is not as critical as in the case of exposed or semi-exposed runner structures.

The problem of buckling of the ceiling structure, particularly to an extent wherein passage of flame and heat is permitted, results primarily from non-uniform expansion in the metal elements. Thus, while a single runner of the exposed type may elongate, under the application of heat, in a straight line corresponding to its longitudinal axis, when portions of the runner are exposed below the ceiling tile and other portions which normally include a relatively heavy reinforcing bead at the extreme upper longitudinal edge of the runner are disposed above the ceiling tile and thus relatively insulated from heat underneath the ceiling, thermal expansion of the runner is dependent upon a number of factors including the manner and number of points at which it is supported and as a considerable temperature differential may exist between the exposed portions of the runner and the concealed relatively insulated portions thereof, the greater expansion of the exposed portions will result in a pronounced bowing action of the runner which is of convex shape as viewed from beneath the cealing whereby the central portion of the runner between spans bows downwardly. If the runner is supported adjacent its ends and also in the middle, forming two or more spans, the central support or supports materially change the expansive action and result in considerable buckling and twisting of the runner as the latter is not free to pursue its natural expansion. Such action readily results in a buckling of the ceiling tiles to a point, permitting the flame and heat to pass therethrough.

The present invention is therefore directed to a suspended ceiling structure which is so constructed that the expansion in the supporting structure is controlled to prevent distortion of the ceiling structure to a point that will permit flame and heat to pass therethrough, thus considerably improving the fire resistant characteristics of a ceiling structure of exposed or semi-exposed type.

The invention has among its objects the production of a suspended ceiling structure having the above advantages which is relatively simple in construction, the control of the expansion of the exposed runners being achieved by the provision of means for localizing excessive stresses on the runner to predetermined portions thereof whereby any distortion in the ceiling structure will be insufficient to permit a rupture thereof and passage of flame and heat therethrough.

A further object of the invention is the production of such a ceiling structure, which is exceedingly simple in construction, permitting its use in substantially any type of mechanical design of runner structures as well as the substitution of runners embodying the invention for runners in existing structures, and which involves substantially no change in installation techniques, etc.

In the drawings wherein like reference characters indicate like or corresponding parts;

FIG. 1 is a top plan view of a portion of a ceiling structure embodying the present invention with portions of the ceiling tile broken away due to disposed details of the construction;

FIG. 2 is a side elevational view of a single supported runner in the absence of heat thereon;

FIG. 3 illustrates the result of the application of heat to a runner such as that illustrated in FIG. 2 when the upper portion of the runner is relatively insulated by ceiling tile;

FIG. 4 is a view similar to FIG. 2 with the runner also supported intermediate its ends to provide two spans;

FIG. 5 is a view similar to FIG. 3, partially illustrating the action of a runner such as illustrated in FIG. 4, but omitting the twisting which normally takes place in such a structure;

FIG. 6 is a figure of a runner constructed in accordance with the present invention, upon the application of heat thereto, illustrating the exaggerated form the action of the stress localizing means;

FIG. 7 is a sectional view through a concealed cross runner and associated ceiling tile, taken approximately on the line 7—7 of FIG. 8;

FIG. 8 is a sectional view through a pair of main runners and associated ceiling tile taken approximately on the line 8—8 of FIG. 7;

FIG. 9 is a side elevational view of an intermediate portion of a main runner illustrating one form of stress localizing means;

FIG. 10 is a side elevational view of a main runner similar to FIG. 9 illustrating a modified form of stress localizing means; and

FIG. 11 is a side elevational view of the end portions of a pair of adjacent aligned main runners illustrating connecting means therefor.

The present invention contemplates the fabrication of a runner structure of the exposed type which is provided with means for localizing the action of expansion forces resulting from the application of heat to the runner whereby deformation of the runner will take place in a predetermined pattern, without undue twisting or buckling action which would otherwise result in a rupture of the ceiling structure, thus preventing the passage of flame and heat therethrough. This is accomplished in the illustrations of the drawings by suitably weakening certain portions of the runner structure, which weakening is insufficient to undesirably effect the normal supporting action of the runner but is sufficient to permit major distortion of the runner to take place at such localized points, which are so placed that the runner will assume a predetermined position which is insufficient to buckle the ceiling structure.

Referring to the drawings and more particularly to FIGS. 1, 6, 7, 8 and 11, the reference numeral 1 indicates generally a suspended ceiling structure of the semi-exposed type employing a plurality of acoustical mineral tile panels 2, illustrated as being generally rectangular in shape and supported by a plurality of parallelly extending main runners 3 which are connected at spaced points by a plurality of cross runners 4, the latter extending in slots in the end edges of the tiles and thus concealed, whereas the main runners have their lower flange portions positioned below the tile panels and thus ex-

posed. Additional reinforcing members 5 may extend between adjacent main runners, as hereinafter described, to further restrict twisting of the main runner structures.

As illustrated in FIGS. 7 and 8, the main runners 3 are each formed from a suitable sheet of strip material folded back upon itself to provide a stem or web portion 6 of double thickness connected along its upper edge by a tubular bead 7 and being provided along its bottom edge with outwardly disposed flange members 8 disposed in a common plane and enclosed by a suitable ornamental cap strip 9, the longitudinal edge portions 11 of which are wrapped around the free edges of the respective flanges 8 as clearly illustrated in FIG. 8. The cross members 4, in the embodiment of the invention illustrated, are constructed similarly to the main runners comprising a stem or web portion 12 formed from two thicknesses of material which are connected at their upper edges by a tubular bead 13 and provided at their lower edges with oppositely disposed flanges 14 having the extreme edges thereof folded back upon themselves as indicated at 15 to provide reinforced edges.

The cross runners are provided with suitable means for interlocking the runner to the main runner, such means, in the embodiment of the invention illustrated, comprising a tongue 16 at each end of the respective cross members, of a size to be inserted in a cooperable slot 17 in the main runner, each tongue being provided with a notch 18 therein of a size to receive the adjacent portion of the stem 6 of the main runner thereby preventing longitudinal movement of the cross runners relative to the main runner. The proportions of the cross runners 4, tongues 16 and slots 17, in the main runner are such that the tile 2 may be supported on the flanges 8 of the main runner with the flanges 14 of the cross runners disposed in cooperable slots 19 in the end edges 21 of the respective tile panels 2, the edge portions 22 of the tile panels disposed above the flanges 14 being cut back to provide space for the web 12 of the cross runner, as clearly illustrated in FIG. 7.

The main runners are adapted to be suitably suspended from an overhead supporting structure as, for example, by a plurality of wire ties 23, secured at their upper ends to the supporting structure, and having their lower ends extending through openings 24 in the main runner with the free end of the ties being wrapped around the main portion thereof, as indicated at 25.

Adjacent ends of the aligned main runners may be connected by a suitable coupling member 26 of a general type such as that currently employed in similar arrangements, the member 26 comprising a flat body portion 27 formed with an open tubular portion 28 of a size to receive the beads 7 of the main runners which are also provided with respective slots 29 in the web portions 6 thereof adapted to receive tongues 31 struck up from the body of the coupling member which following the insertion through the slots 29 are bent upwardly as clearly illustrated in FIG. 11. As illustrated, the end edges 32 of aligned main runners are separated a sufficient distance to accommodate thermo expansion and the gap between the flanges 8 of adjacent runners is adapted to be concealed by a suitable cap member 33 having its longitudinal edge portions 34 wrapped around the adjacent flanges 8 of the respective runners. The cap member 33 may be secured in place by offset portions 35 formed in the edge portions of the cap and adapted to engage the adjacent end edges of the flanges 8. The material and construction of the coupling member 26 and the cap member 33 is such that they will readily permit expanding movement of the main runners toward one another. The construction is also adapted for exposed system wherein the cross runners 4 are of substantially the same size as the main runners 3 and provided with exposed tile supporting flanges.

Referring particularly to FIGS. 2–6, tests have shown that in ceiling assembly, such as that heretofore described, upon the application of heat to the underside of the ceiling structure, the main runners will expand longitudinally, but as the flange portions 8 of the runners are exposed and in direct contact with the applied heat, while the web portions 6 and reinforcing beads 7 are relatively well insulated from the heat by the tile panels 2 whereby the upper portion of the runner will be heated mainly by conduction from the flanges 8, such flange portions of the main runners will tend to expand to a considerably greater extent that the relatively cold web portions and reinforcing beads 7, thereby causing a bow in the runner due to the greater expansion of the flange portions.

FIGS. 2 through 6 disclose single lengths of main runners and illustrate the expansion of such runner under conditions such as that just described wherein the flange portions of the runner are exposed and the upper portions insulated by the acoustical tiles, such tiles, however, not being illustrated in such figures.

Thus FIG. 2 illustrates a runner supported adjacent its ends by ties 23, thereby creating a single span which upon the application of heat, will tend to assume a bowed condition generally corresponding to that illustrated in FIG. 3. Normally a condition such as this would not result in deformation of the runner nor of the ceiling structure to an extent which would permit rupture thereof and passage of flame and heat therethrough, but obviously physical limitations in permissible span lengths would limit the use of such types of construction and it is therefore, in most cases, necessary to provide one or more additional intermediate ties, thereby correspondingly reducing the span length. A construction embodying two unheated spans, is illustrated in FIG. 4.

Upon the application of heat to a multiple span structure such as illustrated in FIG. 4, it will normally tend to act somewhat similar to two individual spans such as illustrated in FIG. 3, but in addition thereto the span will tend to twist and otherwise distort (which is not illustrated in FIG. 5), readily resulting in a sufficient distortion of the ceiling structure to effect a rupture thereof and permit the passage of flame and heat therethrough.

The present invention, as previously mentioned, thus contemplates the construction of a runner which is provided with means for localizing stresses in the multi-span runner suspension whereby the runner may assume the position of a plurality of relatively short straight sections, illustrated in an exaggerated manner in FIG. 6, with stresses in the bead 7 and adjacent upper portion of the runner being relieved, as for example, by separation at the intermediate points of suspension, and the portions of the runner intermediate such points of suspension being constructed to permit stretching thereat whereby the bowing tendency between spans is to a large extent concentrated at the middle of the span. Such action is insufficient to prevent a rupture of the cealing structure but at the same time sufficiently eliminates twisting and similar distortion in the runner to prevent the rupture of the ceiling as a result thereof.

FIGURES 7 and 11 illustrate two embodiments of the invention wherein means is provided for localizing bending action of the upper portion of the main runner adjacent a point of suspension, while FIGURES 9 and 10 illustrate embodiments of the invention for localizing stresses adjacent the portions of a runner intermediate the points of suspension. In the embodiment illustrated in FIG. 7, cylindrical bead 7 is provided with a transversely extending hole 36 therein located in substantially vertical alignment with the slot 17, the opening 36 being of a diameter to leave a connecting portion 37 above the opening and a similar portion 38 below the opening. As illustrated in FIGS. 5 and 6, the tendency of the runner adjacent the middle tie 23 is to go downwardly on opposite sides of the tie placing tension stresses in the reinforcing bead 7, which in prior runners would result in distortion and twisting of the runner. However, in the construction

illustrated, the opening **36** cooperates with the slot **17** to present a local barrier of reduced strength so that upon the application of such tension forces, the bead **7** may be severed at the opening **36** and if necessary, the connecting portion **38** between the opening **36** and the slot **17** may likewise be severed to prevent the runner on opposite sides of the adjacent tie **23** to diverge downwardly as illustrated in FIG. 6.

FIG. 11 illustrates a modified form of the construction illustrated in FIG. 7, wherein the bead **7** is provided with a notch **39** therein of a size to suitably weaken the bead **7** to permit fracture of the bead at the recess, the recess **39**, however, being longitudinally spaced along the bead **7** with respect to the adjacent slot **17**, and where desirable, to provide additional relief, a slit **41** may be made in the web **6**, in vertical alignment with the notch **39**, which slit is operative to perform the same function as the slot **17** in the construction illustrated in FIG. 7. Thus upon the application of heat and the production of tension forces in the upper portion of the runner, the latter may fracture at the notch **39** and the intermediate portion of the bead between the notch and the slit **41** may likewise fracture, if necessary, to accommodate the internal stresses of the runner.

To permit an expansion or stretching of the runner adjacent the mid-portion of each span, the web **6** of the runner may be constructed to have less resistance to stretching than the remaining portion of the runner so that a localized stretching thereof may take place at the desired predetermined intermediate points of the respective spans.

FIGURES 9 and 10 illustrate two embodiments of this feature of this invention. In FIG. 9 the web portion **6** of the runner adjacent the flanges **8** is provided with an area **42** having a plurality of openings **43** therein which are illustrated as being of generally elongated shape and extending parallel to one another in the longitudinal direction of the runner. The openings **43** provide an area of low stretching resistance which, while adequate to normally support the associated elements of the ceiling structure, under the action of heat applied to the runner, may stretch in response to tension forces at each side thereof to permit the intermediate portion of the runner to diverge upwardly at opposite sides thereof, as illustrated in FIG. 6.

In the embodiment illustrated in FIG. 10, the weakened area **42** comprises a series of generally elongated openings **44** which are disposed in vertical orientation to form a generally triangularly shaped area for accommodating the desired stretching of the web portion and, as illustrated, may extend partially into the flange to permit stretching of the flange portions as well as the web.

The invention is also applicable to constructions wherein the runners are so disposed that four runner ends are formed at a single intersection, in which case the coupling member **26** would be suitably formed to receive the intersecting runners.

It will also be noted that by suitable designing of the system, and provision of an adequate number of expansion points, the latter would be adequate to accommodate runner expansion and runner ends could therefore be butted without provision for expansion at such points.

It will be apparent from the above disclosure, we have provided an integrated structure for resisting extreme distortions in the ceiling structure, particularly the supporting elements thereof whereby means is provided for adequately localizing distortion stresses in the runners resulting from the application of heat to the lower face of the ceiling structure whereby such forces are sufficiently relieved to prevent a rupture of the ceiling and the passage of flame and heat therethrough.

To provide further resistance to distortional forces on the ceiling, particularly twisting of the main runners, additional reinforcing members **5** may be provided, which in the embodiment of the invention illustrated, comprise relatively narrow strips of metal which are suitably formed along their upper edges to produce a generally tubular bead **45** and a depending flange or web **46**, which is provided with a pair of generally circular opening **48** therein of a size to receive the tubular beads **7** of the main runners and having the centers of such openings spaced the same distance as the center line distance between the main runners **3**. As illustrated in FIG. 8, the portion **46** of the strip **5** may be provided with a slot in the connecting portion of the strip between the openings **48** and the adjacent longitudinal edge of the strip to form a pair of oppositely disposed ears or tabs **49** which may be initially bent out of the plane of the web **46** sufficiently to permit insertion of the strip on the main runners following which the tabs **49** may be bent inwardly to position the same more or less within the plane of the web **46**, thereby locking the reinforcing strip to the main runners, and thereby maintaining the upper portion of the main runners in substantially parallel alignment. In the event the reinforcing bead is of a different cross-sectional shape, the openings **48** may be shaped accordingly.

It will be noted from the above disclosure that we have provided a novel ceiling suspension structure which is designed to provide controlled distortion in the suspension system upon the application of heat to the underside of the ceiling structure and by means of such control, prevent rupture of the ceiling and passage of flame and heat therethrough.

It will also be noted that the construction is such that runners of existing suspension systems may be readily replaced with those embodying the invention, the runners of the invention being compatible with and capable of being substituted for existing runners in many of the prior types of suspension systems.

Having thus described our invention, it is obvious to those skilled in the art from the disclosure herein given, that various immaterial modifications may be made in the same without departing from the spirit of our invention; hence we do not wish to be understood as limiting ourselves to the exact form, construction, arrangement and combination of parts herein shown and described, or uses mentioned.

What we claim as new and desire to secure by Letters Patent is:

1. A runner for supporting tile ceiling elements in a fire-resistant suspended ceiling system, said runner having lower tile supporting portions along the bottom edge of the runner and upper portions disposed thereabove, said tile supporting portions being so disposed in the assembled fire-resistant suspended ceiling system that upon the application of heat to the ceiling face of such a fire-resistant suspended ceiling system unequal stresses are created in the runner, said upper portions of the runner having means at spaced points therealong for providing areas of reduced distortion resistance, operative upon the application of heat to the lower portions of the runner to localize major distortion of the runner to said areas, said runner including a bead and provided with a slot therein for the reception of a portion of a cross runner, said bead having an area forming one of said areas of reduced distortion resistance so positioned along said bead that it is adjacent to but longitudinally spaced from said slot, and an upper portion of said runner being provided with a transversely extending cut therein substantially aligned with said area of reduced distortion resistance of said bead.

2. A runner for fire-resistant suspended ceiling structures comprising a strip formed to provide a pair of oppositely disposed longitudinally extending tile supporting elements, a central suporting web for said tile supporting elements which are connected thereto adjacent the bottom longitudinal edge of such web, said web including means thereon at spaced points for receiving suspension elements therefor, said web including means thereon for localizing excessive stress and disposed intermediate said

spaced points for providing a reduced area of reduced stretching resistance at said intermediate portions to facilitate stretching of the web thereat upon expansion of said tile supporting elements upon the application of heat to the tile supporting elements, said area formed by a plurality of openings in the web, said openings being disposed to reduce the stretching resistance of the web at said area, said openings extending generally parallel to one another and transverse to the runner axis, and said openings extending into said tile supporting elements.

3. A runner for fire-resistant suspended ceiling structures comprising a strip formed to provide a pair of oppositely disposed longitudinally extending tile supporting elements, a central supporting web for said tile supporting elements which are connected thereto adjacent the bottom longitudinal edge of such web, said web including means thereon at spaced points for receiving suspension elements therefor, said web including means thereon for localizing excessive stress and disposed intermediate said spaced points for providing a reduced area of reduced deformation resistance at said intermediate portions to facilitate deformation of the web thereat upon expansion of said tile supporting elements upon the application of heat to the tile supporting elements, said area formed by a plurality of openings in the web, said openings being disposed to reduce the deformation resistance of the web at said area, said openings extending generally parallel to one another and transverse to the runner axis, and said openings extending into said tile supporting elements.

4. A runner for fire-resistant suspended ceiling structures comprising a strip formed to provide a pair of oppositely disposed longitudinally extending tile supporting elements, a central supporting web for said tile supporting elements which are connected thereto adjacent the bottom longitudinal edge of such web, said web including means thereon at spaced points for receiving suspension elements therefor, said web including means thereon for localizing excessive stress and disposed intermediate said spaced points for providing a reduced area of reduced deformation resistance at said intermediate portions to facilitate deformation of the web thereat upon expansion of the tile supporting elements upon the application of heat to the tile supporting elements, said area formed by a plurality of openings in the web, said openings being disposed to reduce the deformation resistance of the web at said area, and said openings extending generally parallel to the runner axis and disposed in a generally triangular configuration.

5. A runner for fire-resistant suspended ceiling structures comprising a strip formed to provide a pair of oppositely disposed longitudinally extending tile supporting elements, a central supporting web for said tile supporting elements which are connected thereto adjacent the bottom longitudinal edge of said web, said web including means thereon at spaced points for receiving suspension elements therefor, said web including means thereon for localizing excessive stress and disposed intermediate said spaced points for providing a reduced area of reduced deformation resistance at said intermediate portions to facilitate deformation of the web thereat upon expansion of said tile supporting elements upon the application of heat to the tile supporting elements, said area formed by a plurality of openings in the web, said openings being disposed to reduce the deformation resistance of the web at said area, and said openings extending into said tile supporting elements.

6. A runner for fire-resistant suspended ceiling structures comprising a strip formed to provide a pair of oppositely disposed longitudinally extending tile supporting elements, a central supporting web for said tile supporting elements which are connected thereto adjacent the bottom longitudinal edge of said web, said web including a reinforcing element along the upper longitudinal edge thereof, said web including means thereon at spaced points for receiving supporting elements therefor, means adjacent said spaced points for providing an area of reduced distortion resistance at said reinforcing element whereby said reinforcing element may expansively distort thereat upon the application of heat to the lower exposed portion of said runner, means on said web disposed intermediate said spaced points for providing an area of reduced distortion resistance at said intermediate portions to facilitate deformation of the web thereat upon deformation of said tile supporting elements upon the application of heat to the tile supporting elements, and said areas of reduced distortion resistance formed by removal of portions of the runner structure.

7. A ceiling suspension grid system comprising a plurality of runners disposed in generally parallel relation, a plurality of cooperable cross runners extending transversely to said first mentioned runners and connected thereto, a plurality of ceiling tile extending between and supported by said runners, portions of said runners being exposed below the ceiling tiles and the other portions of the runners extending above said ceiling tiles, suspension elements connected to the last mentioned portions of said runners at spaced points therealong for supporting the latter therefrom, portions of said runners adjacent said points of suspension having reduced distortion resistance to partially localize deformation of the adjacent portion of the associated runner positioned above said tiles, portions of said runners intermediate said points having reduced distortion resistance to partially localize deformation of exposed portions of the runner, and said portions of reduced distortion resistance formed by cutting selected portions of the runners, whereby upon the application of heat to the exposed portions of the runners, the runners will tend to diverge downwardly from the points of suspension and upwardly from said intermediate points to prevent a rupture of the ceiling resulting from runner distortion.

8. A ceiling suspension grid system comprising a plurality of runners disposed in generally parallel relation, a plurality of cooperable cross runners extending transversely to said first mentioned runners and connected thereto, a plurality of ceiling tile extending between and supported by said runners, portions of said runners being exposed below the ceiling tiles and the other portions of the runners extending above said ceiling tiles, suspension elements connected to the last mentioned portions of said runners at spaced points therealong for supporting the latter therefrom, portions of said runners adjacent said points of suspension having reduced distortion resistance to partially localize deformation of the adjacent portion of the associated runner positioned above said tiles, portions of said runners intermediate said points having reduced distortion resistance to partially localize deformation of exposed portions of the runner, and reinforcing elements extending between adjacent pairs of runners and mounted upon portions of said adjacent pairs of runners extending above said ceiling tiles to restrict twisting of the associated runners, whereby upon the application of heat to the exposed portions of the runners, the runners will tend to diverge downwardly from the points of suspension and upwardly from said intermediate points to prevent a rupture of the ceiling resulting from runner distortion.

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