

June 15, 1965

H. ZNAMIROWSKI
CEILING CONSTRUCTION

3,189,138

Filed Oct. 24, 1961

4 Sheets-Sheet 1

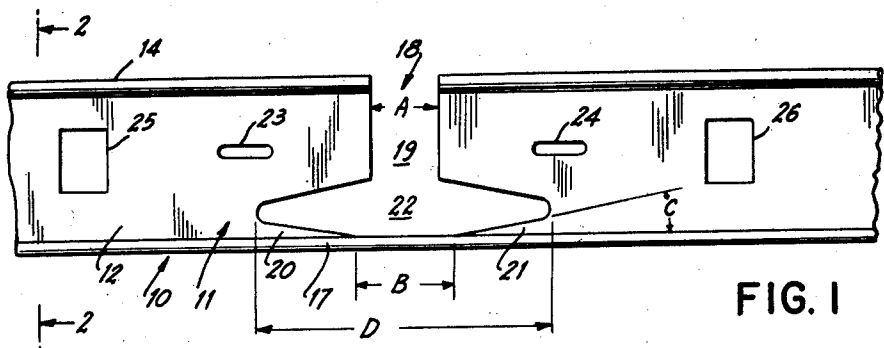


FIG. 1

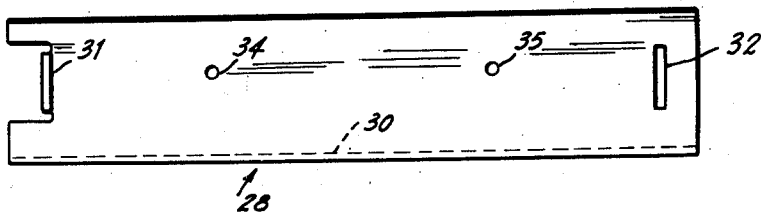


FIG. 3

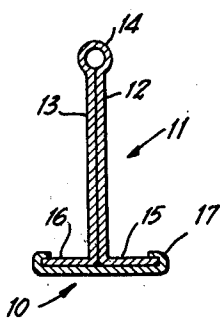


FIG. 2

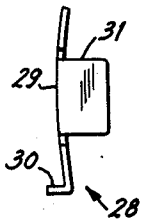


FIG. 4

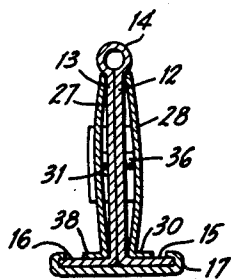


FIG. 6

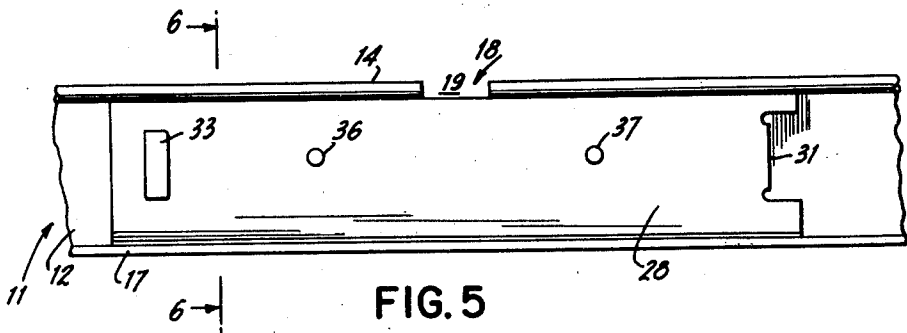


FIG. 5

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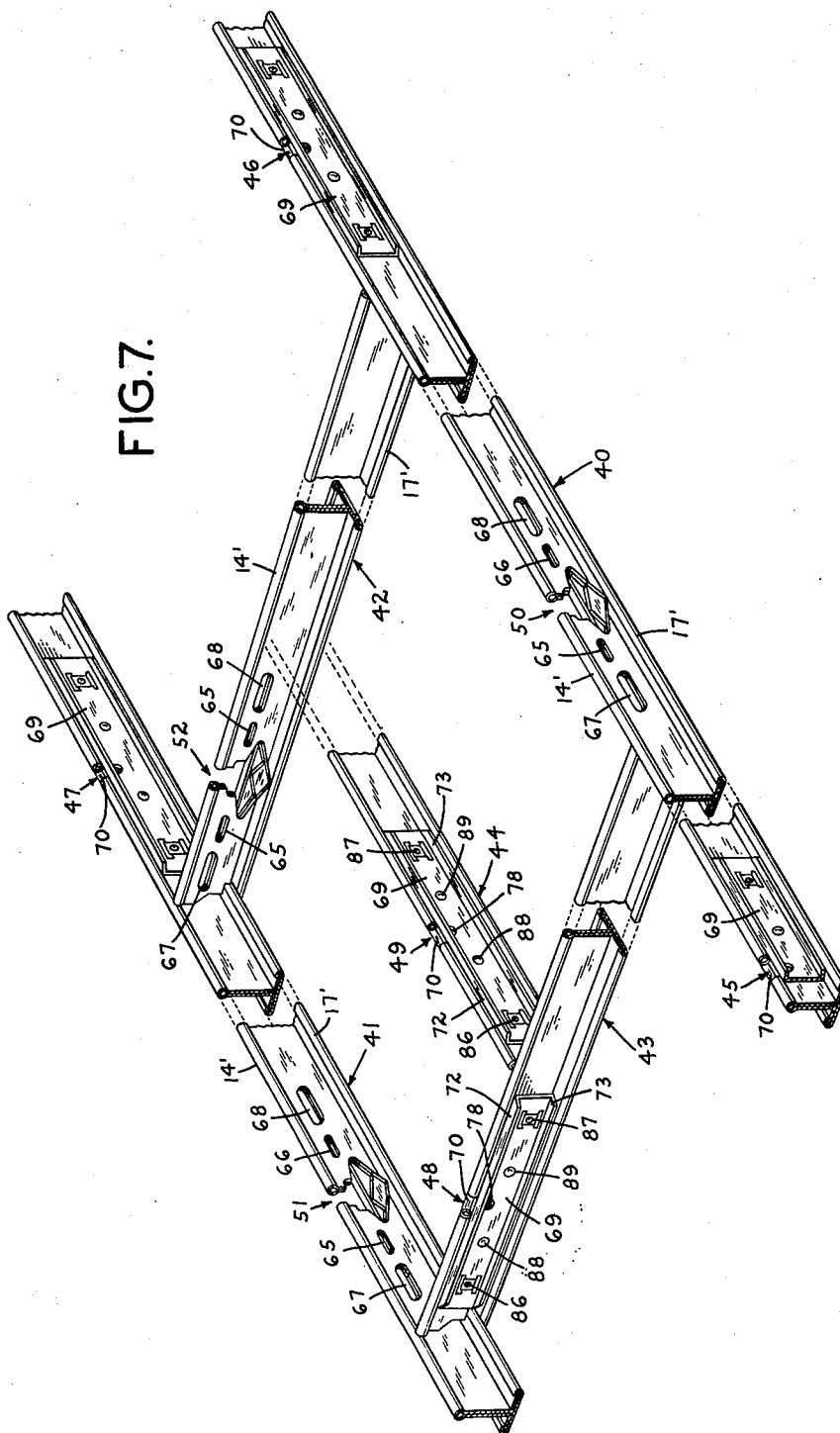
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FIG. 7.



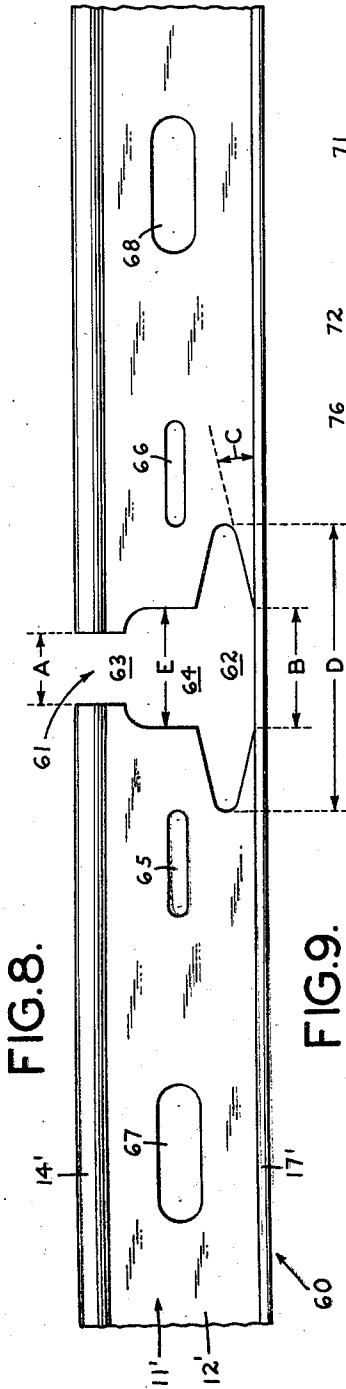
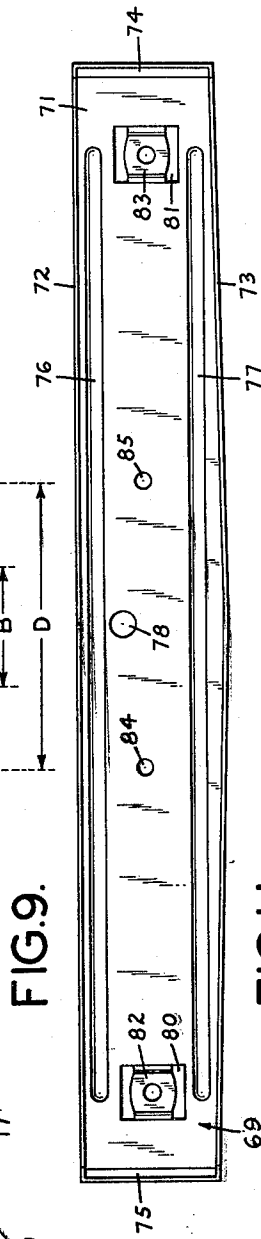
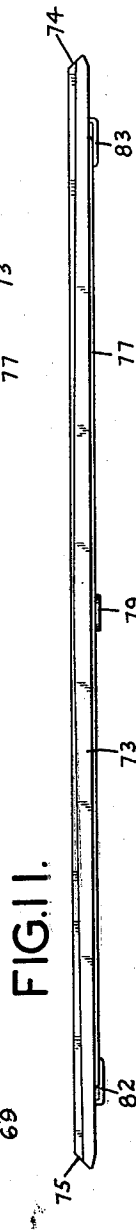
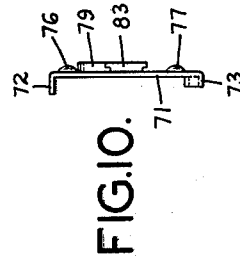
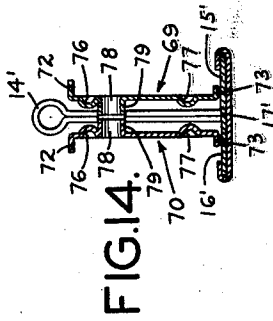
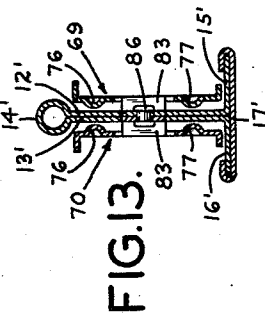
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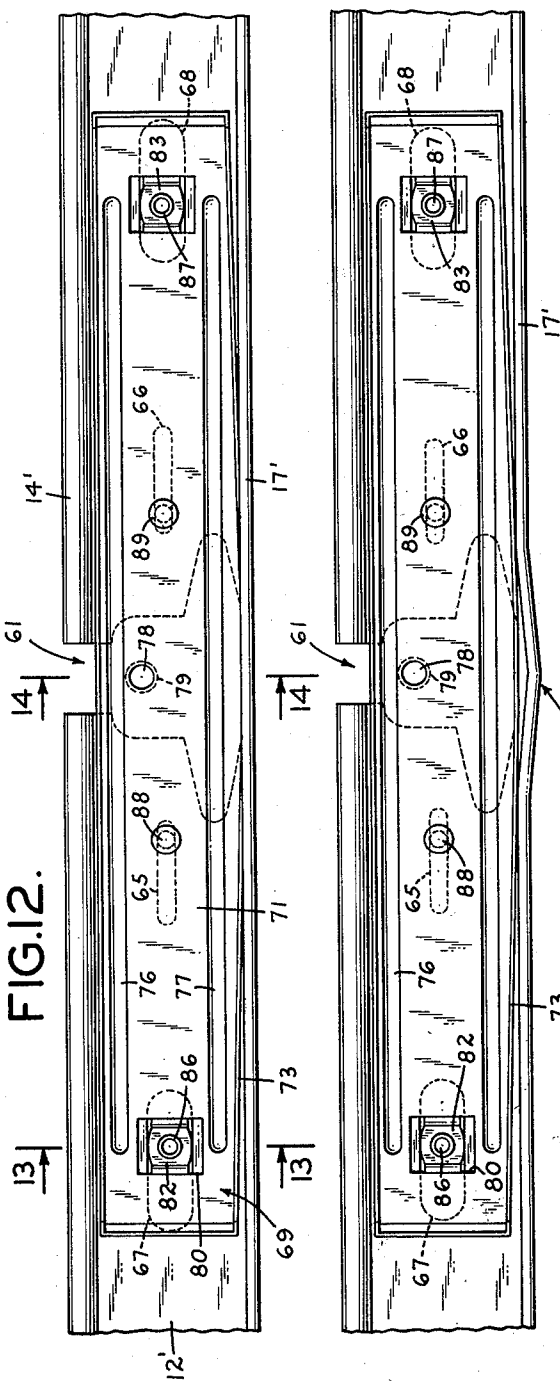


FIG.15.

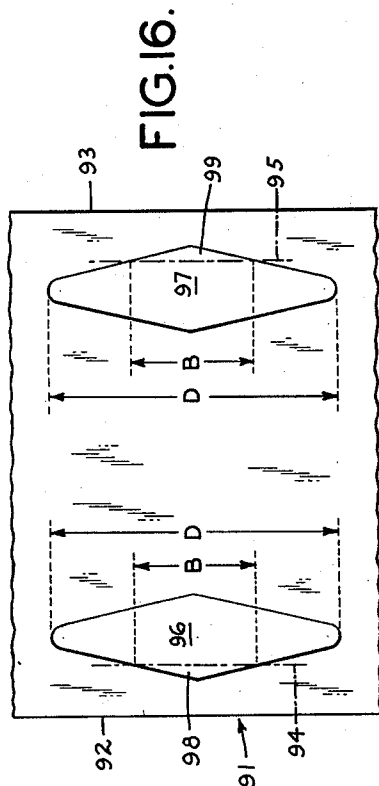
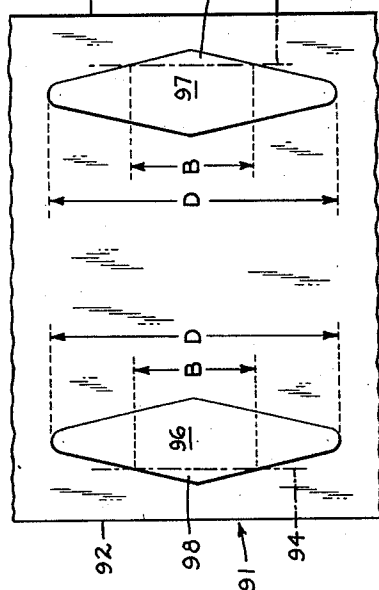


FIG.16.



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CEILING CONSTRUCTION

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10 Claims. (Cl. 189—37)

The present invention relates to ceiling constructions and more particularly to suspended ceiling constructions in which a metallic grid system is suspended from primary ceiling members and used to support acoustical tiles and other ceiling panels. This is a continuation-in-part of my application Serial No. 100,602, filed April 4, 1961, now abandoned.

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. An example of the former type is the ceiling system shown in United States Patent 2,963,130 to Rosenbaum which issued December 9, 1960, while an example of the latter type is the ceiling system shown in United States Patent 2,866,233 to Lydard which issued December 30, 1958.

When the metal beams of a ceiling suspension system are subjected to the high temperatures which accompany fires, the beams tend to twist and buckle and to break and drop the ceiling panels onto the floor beneath. Such buckling of the beams results from the restraint imposed on expansion of the individual beams by the grid construction and the contact thereof with the walls or other side members of the enclosure. Thus even though ceiling panels which are highly resistant to fire conditions have been developed, much of the fire retarding advantage of such panels is lost when the panel suspension system buckles and allows some or all of the panels to fall. Falling of the panels may be due to removal of support or to breaking of the panels or to both.

Some attempts have been made to provide grid constructions which will accommodate the expansion forces resulting from the high temperature occurring with fires and some of these attempts have resulted in suspended ceilings which will in many cases resist buckling of the beams and dropping of the panels for a sufficient time interval to afford satisfactory fire retardation. But the fire retarding suspended ceiling constructions heretofore proposed have presented installation complexities which greatly increase the cost of installations. Moreover, such systems if not installed with great care have a tendency to buckle despite the expansion compensation provided for in the design thereof.

It has been a principal object of the present invention to provide a novel and improved suspended ceiling construction.

More particularly it has been an object of the invention to provide a novel and improved suspended ceiling construction which affords improved fire retarding characteristics without introducing additional installation complexities.

Another object of the invention has been to provide a novel and improved suspended ceiling construction which will resist fire temperatures for prolonged periods of time

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without buckling and without breaking and dropping the ceiling panels.

A further object of the invention has been to provide a novel and improved beam which is especially adapted for use in fire retarding ceiling constructions.

Still another object of the invention has been to provide a novel and improved beam for a fire retarding ceiling which can be used with any desired fastening system.

Other and further objects, features and advantages of the invention will appear more fully from the following description taken in connection with the appended drawings in which:

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 side elevational view of a reinforcing plate for use in the beam of the invention;

FIG. 4 is an end elevational view of the plate of FIG. 3;

FIG. 5 is a side elevational view of a beam with reinforcing plates assembled thereto;

FIG. 6 is a cross-sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a perspective drawing illustrating a portion of a suspended ceiling grid system embodying the invention;

FIG. 8 is a side elevational view illustrating a modified form of beam construction in accordance with the invention;

FIG. 9 is a side elevational view of a modified form of reinforcing plate or expansion splice for use in the beam of the invention;

FIG. 10 is an end elevational view of the plate of FIG. 9;

FIG. 11 is a bottom plan view of the plate of FIG. 9;

FIG. 12 is a side elevational view of the beam of FIG. 8 having reinforcing plates of the type shown in FIGS. 9—10 assembled thereto;

FIG. 13 is a cross-sectional view taken along the line 13—13 of FIG. 12;

FIG. 14 is a cross-sectional view taken along the line 14—14 of FIG. 12;

FIG. 15 is a side elevational view similar to FIG. 12 illustrating a typical response of the beam of FIG. 12 to fire conditions; and

FIG. 16 is a plan view of a length of sheet metal illustrating a pre-blanking operation in accordance with the invention.

Referring now to the drawings, FIGS. 1 and 2 illustrate a typical suspended ceiling beam 10 embodying the invention. The beam 10 might be either a main runner or a cross T and comprises an upstanding web 11 formed from vertical portions 12 and 13 joined at the top by a rounded rib 14. Portions 12 and 13 are provided with outwardly extending flanges 15 and 16, respectively, which form ceiling panel supporting surfaces. As best shown in FIG. 2 the beam in cross-section is essentially an inverted T shape. A decorative flange cover 17 caps the flanges 15 and 16 to provide an attractive under surface which is desirable in installations where the under surface of the beam forms a visible part of the installed ceiling. The web portions 12, 13 and 14 and the flanges 15 and 16 are rolled from a single sheet of metal and are typical of a steel beam construction. For aluminum beams it would generally be desirable to extrude the inverted T section rather than rolling the section from sheet metal, in which case the upstanding web would be formed from a single thickness. In view of the low melting point of aluminum, such beams are of limited value in a fire retarding ceiling.

Only a short length of the beam 10 is shown in FIG. 1. 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 T or bridging T the beam 10 might typically be two or four feet long. In a grid system such as is shown in the aforementioned Rosenbaum patent, cross T's and main runners have the same general cross-sectional shape but the height of the cross T's is considerably less than the height of the main runners.

The web 11 of the beam 10 is provided at suitable intervals with an axially (longitudinally) extending cut-out portion 18 which may be termed an expansion relief section. The expansion relief section 18 extends throughout the height of the upstanding web 11 and has a minimum axial dimension A. The axial dimension A 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. Typically, for steel beams expected to be exposed to a maximum temperature of 2000° F. the dimension A will be ½ inch with one expansion relief section provided for every four feet of beam length. When the actual steel temperature exceeds about 1500° F., the metal becomes somewhat plastic and the compressive stresses which tend to cause buckling are replaced with tension stresses, resulting from elongation and downward bowing of the steel beams.

The expansion relief section 18 has an upper portion 19 whose axial length is the dimension A and whose height is not critical and which might be, for example, 1 inch for an overall beam height of 1½ inches or ¾ inch for an overall beam height of 1¾ inches. It is desirable that the dimension A be kept as short as possible to limit the take up at each expansion joint, for its respective unit of length, for this system 4 ft.

The axial length of relief section 18 at the base of web 11, shown as dimension "B," should be greater than dimension A and the edges of web wall areas 20 and 21 extending from the bottom of the relief section should be angularly disposed with respect to the plane of the flanges 15 and 16, this angle being designated dimension "C." Areas 20 and 21 merge into the remainder of the web wall at maximum dimension "D" of relief section 18. By way of example, for steel beams of the type described dimension B might be one inch, angle C might be 13°, and dimension D might be 2¼ inches. As illustrated in FIG. 1, the lower portion 22 of relief section 19 is shaped somewhat as a flattened diamond.

When the beam 10 is subjected to the temperature rise which accompanies fire conditions the beam will tend to expand in an axial direction. Since the ends of the beam will be restrained against lengthening either by contact with another beam or with a wall, the expansion stresses will have to be accommodated otherwise than by lengthening of the beam in an axial direction. So far as the web 11 is concerned, expansion of the web metal is accommodated by the expansion relief section 18 or, in the case of a long beam, by a number of such expansion relief sections. So far as the flanges 15 and 16 (and the cap 17) are concerned, the expansion stresses will be taken up by a downward buckling of the flanges 15 and 16 in the region of dimension B.

Downward buckling of the flanges 15 and 16 in the region of dimension B will not act to drop ceiling panels supported by the flanges 15 and 16 whereas lateral buckling of these flanges would tend to drop the ceiling panels. By lateral buckling is meant bending of the flanges 15 and 16 in a plane normal to the plane of web 11. In the case of an unrelieved beam restrained against elongation, fire temperatures will likely produce buckling components in both planes. But in accordance with the invention expansion stresses in the web are accommodated by the provision of one or more expansion relief sections and expansion stresses in the flanges are accommodated by

producing downward bending of the flanges over a limited length of the beam.

The absence of the web in contact with the flanges over the dimension B means that the flanges 15 and 16 will not be so stiff in this region as they will be in the remaining portion of the beam where the presence of the web has a substantial stiffening effect on the flanges. Hence the flanges will be weakest in the dimension B and expansion stresses in the flanges will produce bending in this weakest portion in preference to the stiffer portions. Moreover, provision of the tapered web portions 20 and 21 results in a downward component of the horizontal expansion stresses in the web 11 acting to urge flanges 15 and 16 downwardly rather than laterally or upwardly. Upward bending of the flanges would tend to jam the reinforcing plates (which will be described hereinafter) and such jamming might produce the undesirable lateral buckling which tends to break and drop the ceiling panels.

It will be evident that provision of the enlarged lower portion 22 of relief section 18 tends to insure that buckling of the ceiling panel supporting flanges will not have any substantial lateral component which would tend to break and drop the ceiling panels.

If the relief section 18 were rectangular throughout the web height, flanges 15 and 16 would be stiffened because of the presence of the web directly adjacent the portion of the flanges located in the region of the relief section. Such stiffening would tend to permit appreciable upward or lateral buckling of the flanges as described. The stiffening effect could be reduced by increasing the axial length of the relief section substantially beyond that length required to accommodate expansion stresses in the web. However, the resulting beam would be considerably weakened as a structural member, and buckling might still occur upwardly as well as downwardly.

An axially elongated slot 23 is provided in web 11 at an intermediate height and at one side of relief section 18. A similar slot 24 is provided at the other side of relief section 18. The slots 23 and 24 have rounded ends and the rounded end center line-center line length of each slot might be ¾" for a dimension A of ½". Rectangular slots 25 and 26 are provided in web 11 at intermediate heights and axially beyond the slots 23 and 24 on respective sides of relief section 18.

The slots 23-26 are provided for attachment of reinforcing plates 27 and 28 to opposite sides of web 11 as shown in FIG. 6. The reinforcing plate 28 is shown in detail in FIGS. 3 and 4 and comprises an arcuate upstanding web 29 and an outwardly extending flange 30 at the base of web 29. An outwardly extending lug 31 is struck from one end of web 29, so as to extend laterally from the concave side of the web 29. A rectangular slot 32 is provided adjacent the other end of web 29 to accommodate a lug 33 which protrudes from plate 27 in the same relative position as the lug 31 protrudes from plate 28. A pair of holes 34 and 35 are provided in web 29 to accommodate rivets 36 and 37 (FIG. 5).

The plates 27 and 28 are identical but in installation each is faced so that the concave side faces of the web 11 of beam 10. Specifically, the plate 28 faces portion 12 and plate 27 faces portion 13. The bottom flange 30 of plate 28 rests on flange 15 while the corresponding bottom flange 38 of plate 27 rests on flange 16.

The lug 33 protruding from the side of plate 27 passes through slot 25 in web 11 (portions 12 and 13) and through slot 32 in web 29, being bent over as shown in FIG. 5. The lug 31 similarly passes through slot 26 in web 11 and the corresponding slot in plate 27 and is bent over. The rivet 34 passes through the hole 34 in plate 28, the slot 23 in web 11 and the hole in plate 27 corresponding to hole 35. The rivet 37 passes through hole 35 in plate 28, through slot 24 and through the hole in plate 27 corresponding to hole 36. The rivets 36 and 37 and the lugs 31 and 33 hold the plates 27 and 28 tightly against the sides of web 11, the contact being line contact

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at the tops and bottoms of the plates 27 and 28 because of the arcuate shape of these plates.

The rivets and lugs fit snugly in the holes and slots in plates 27 and 28 to maintain alignment of these plates. However, the rivets and lugs act in elongated slots in portions 12 and 13 forming web 11 so that as the web 11 is subjected to expansive forces due to a temperature rise the lugs and rivets will not restrain motion of the web 11 but such motion will be accommodated by the axially elongated slots 23-26. The total expansion of web 11 which the slots 23 and 24 should accommodate is the same as dimension A and similarly the total expansion of web 11 which the slots 25 and 26 should accommodate is dimension A.

The use of two fastening means between the plates 27 and 28 on each side of relief section 18 is desirable to maintain vertical alignment of plates 27 and 28, especially under fire conditions in which the portions of the web 11 on both sides of the relief section 18 are expanding to occupy the relief section; however, the lugs could conveniently be replaced with rivets or vice versa.

The arcuate shape of the reinforcing plates 27 and 28 is desirable to insure good contact between the plates and the web 11 even though the rivets and lugs might be slightly loose; any such looseness will be taken up by the spring action of the arcuate plates so long as they are initially fastened tightly to web 11. Preferably the fastening is accomplished so as to put the plates 27 and 28 into slightly tensioned condition, i.e., to reduce slightly their concavity so that they are constantly urged to return to a slightly more concave shape.

Another important advantage which accrues from the arcuate shape of the reinforcing plates 27 and 28 lies in the reduced tendency for the plates to adhere to the sides of the web 11 and thus inhibit expansion of the web under fire conditions. Thus if substantial surface contact of the reinforcing plates and the webs were provided there would be a tendency for the reinforcing plates to adhere to the sides of the web under fire conditions. Such adherence would create force components which might result in lateral buckling of the beam 10. For the same reason it is generally undesirable for the reinforcing plates to be joined by a member in contact with the top surface of the beam. The flanges 30 and 38 which are in contact with the flanges 15 and 16 assist the reinforcing plates in affording rigidity and stability to the beam despite the presence of the relief section 18, but these flanges 30 and 38 are preferably kept relatively narrow to avoid undue surface contact.

A portion of a typical suspended ceiling grid system in accordance with the invention is illustrated in FIG. 7. In FIG. 7 there are shown portions of two main runners 40 and 41, two cross T's 42 and 43 and a bridging T 44. The main runners may be of any desired length; standard 12 foot lengths are typical. The cross T's are usually 2 feet or 4 feet long to accommodate the usual 2' x 4' ceiling tiles or panels. Where ceiling tiles or panels of 2 foot widths are to be used, considerable saving may be achieved by maintaining the usual 4 foot spacing between main runners and using a bridging T running from the middle of one cross T to the middle of the next cross T. Thus an additional main runner is avoided. If tiles of 4 foot width were to be used, the bridging T 44 of FIG. 7 would be omitted.

In FIG. 7 the fastening means joining the cross T's and main runners have been omitted since such means form no part of the invention and any desired means can be used, e.g., the fastening system of the Rosenbaum patent mentioned above. In FIG. 7 complete expansion relief joints are illustrated at 45 and 46 in main runner 40, at 47 in main runner 41, at 48 in cross T 43 and at 49 in bridging T 44. Expansion relief joints with the reinforcing plates omitted are shown at 50 in main runner 40, at 51 in main runner 41 and at 52 in cross T 42. Omission of the reinforcing plates is only for purposes of il-

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lustration since in an actual ceiling construction they would of course be provided. Indeed, the reinforcing plates are assembled to the beams at the factory where the beams are made and the workmen installing a ceiling in the field find no difference in installing the fire retarding ceiling of the invention over installing a similar ceiling without the fire retarding construction. The expansion joints illustrated in FIG. 7 are of the type which will be described below in connection with FIGS. 8-15.

It is preferable to provide an expansion joint in each beam for each tile length. Thus, if main runner 40 is 12 feet long and the tiles to be supported on its flanges are four feet long it is preferable that the necessary expansion be accommodated with three expansion joints located so that one will be opposite each tile length. For example, the spacing between expansion joints 45 and 50 may be 4 feet and the spacing between joints 50 and 46 may be 4 feet. Each expansion joint might have, for example, a beam web expansion space of $\frac{1}{2}$ inch, allowing for a total beam web expansion of $1\frac{1}{2}$ inches.

It is desirable that the expansion joints in the main runners be located so as not to interfere with attachment of cross T's, which in FIG. 7 may be at any of the holes such as those designated 53. It has been found preferable to locate the expansion joint in each cross T near one end of the cross T since this tends to reduce ceiling stresses under fire conditions. For example, in a four foot cross T the vertical center line of the expansion joint might be about eight inches from one end of the cross T.

An important advantage obtained from the expansion joint construction of the invention is that each beam is provided with the requisite expansion accommodation without depending upon any other beam. Thus no critical alignment factors between abutting beams are presented. Where alignment between abutting beams is more critical than necessary for ordinary ceiling installation, a serious problem is presented which tends substantially to increase installation cost. But with the system of the present invention installation costs are unchanged because so far as the workmen are concerned the installation techniques are unchanged.

A modified form of construction in accordance with the invention is illustrated in FIGS. 8-12. The form of construction in FIGS. 8-12 is preferred because it overcomes a problem which may arise with the previously described construction, particularly if the reinforcing plates are fastened too tightly to the beam web. In such case the reinforcing plates may adhere to the beam web and interfere with expansion of the web into the relief space.

Referring to FIG. 8, the beam 60 might be either a main runner, a cross T, or a bridging T, and comprises an upstanding web and outwardly extending flanges which may be identical to those illustrated in FIG. 1 and are designated by like but primed reference numerals.

The expansion relief section 61 of FIG. 8 is shaped somewhat differently than the expansion relief section 18 of FIG. 1. Thus, expansion relief section 61 has a lower portion 62 corresponding to the lower portion 22 of FIG. 1, but the upper portion is divided into a space 63 (corresponding to space 19) and an intermediate space 64 having an axial length E somewhat greater than the dimension A. Thus, if dimension A were $\frac{9}{16}$ inch, dimension E might be $\frac{15}{16}$ inch. Typically, dimension B might be $\frac{15}{16}$ inch, dimension C might be 13° , and dimension D might be $2\frac{3}{4}$ inches.

Axially elongated slots 65 and 66 are provided on opposite sides of expansion section 61 and correspond to slots 23 and 24. If the overall beam height were $1\frac{1}{2}$ inches, the horizontal center line of slots 65 and 66 might be $\frac{3}{8}$ inch above the top surfaces of flanges 15 and 16. Axially elongated slots 67 and 68 are provided on opposite sides of expansion section 61 and are horizontally aligned with and axially outwardly spaced from the slots 65 and 66. Typically, the vertical center lines of the slots 65 and 66

might each be spaced $1\frac{1}{8}$ inches from the vertical center line of section 61, while the vertical center lines of slots 67 and 68 might each be spaced $3\frac{1}{16}$ inches from the vertical center line of section 61.

The expansion section 61 in web 11' is spanned on each side of the web by a respective one of reinforcing plates or expansion splices 69 and 70. The splices 69 and 70 may be identical in construction but one will be reversed end for end on installation. The details of splice construction are illustrated in FIGS. 9-11.

The splice comprises a flat body or web 71 having outwardly extending flanges 72 and 73 at the top and bottom, respectively, and outwardly extending flanges 74 and 75 at respective ends. "Outwardly" refers to the direction from the beam web when the splice plate is installed. The axial center of flange 73 is horizontal for a short length at the center, e.g., $\frac{1}{2}$ inch, and then tapers upwardly slightly towards the ends. Typically, the splice plate might be $\frac{3}{4}$ inches long, and the difference in height between the center and ends of flange 73 might be .093 inch.

Elongated horizontal grooves 76 and 77 are provided adjacent the top and bottom, respectively, of web 71 and form inwardly extending flanges having rounded cross sections. A hole 78 is extruded at the axial center of the splice plate beneath the flange 76. The walls of the extruded hole 78 form an annular inwardly extending flange 79.

A pair of rectangular slots 80 and 81 are provided adjacent respective ends of the splice plate. A central portion of the metal in each of these slots is not removed but forms inwardly extending flanges 82 and 83, respectively.

Circular holes 84 and 85 are provided on opposite sides of the vertical center line of the splice plate.

In assembly, as shown in FIGS. 12-14, an expansion splice is applied to each side of the beam web with the flanges 79, 82 and 83 of each splice in alignment with the corresponding flange of the other splice and with the central portion of flange 73 of each splice resting on the upper surface of the beam flange. Thus, the flange 82 of plate 69 is aligned with the flange 83 of plate 70 and the flange 83 of splice 69 is aligned with the flange 82 of splice 70, the aligned flanges extending into and meeting in the elongated slots 67 and 68. The meeting aligned flanges are rigidly attached together, as by means of rivets 86 and 87 acting in holes in the centers of the flanges 82 and 83.

A rivet 88 extends through hole 84 in splice 69, elongated slot 65 in web 11', and hole 85 in splice 70. A rivet 89 extends through hole 85 in splice 69, elongated slot 66 in web 11', and hole 84 in splice 70. The rivets 88 and 89 cooperate with the rivets 86 and 87 in retaining the splice plates 69 and 70 in axial and vertical alignment.

The flanges 79 of the two splice plates meet in the space 64, as best shown in FIG. 14. Contact between the flanges 79 and contact between the corresponding pairs of flanges 82, 83 limits inward motion of the splice plates and hence prevents the splice plates from adhering to the beam web under fire conditions. The inwardly extending flanges 76 and 77 likewise prevent any surface contact of the beam web with the splice plates should any lateral distortion of the splice plates or the beam web occur under fire conditions. The contact between the flanges 73 and the beam flanges is limited to the central regions of the flanges 73 by reason of the upward taper of the flanges 73, which also helps prevent freezing of the splice plates to the beam.

The inward extent of the flanges 79, 82 and 83 is preferably made sufficient so that the spacing between the respective flanges 76 and the spacing between the respective flanges 77 is slightly greater than the web thickness. These flanges thus act as spacers. By way of example, if the beam were rolled from .025 inch stock so that the web thickness was .05 inch, the flanges 79, 82 and 83 might extend inwardly .062 inch. The clearance between

the expansion plates and the beam web will be reduced by the flanges 76. The vertical height of the flanges 82 and 83 is preferably slightly less than the vertical height of the slots 67 and 68. For example, the slots 67 and 68 might be .312 inch high and the flanges .306 inch high. Moreover, the upper and lower surfaces of the flanges 82 and 83 are preferably rounded, as shown. This construction avoids binding of the flanges 82 and 83 on the slot walls. The diameter of the bodies of rivets 88 and 89 is preferably slightly less than the height of the slots 65 and 66, respectively.

As the beam temperature increases upon exposure to fire conditions, axial motion of the beam web under the resulting compression stresses will reduce the axial extent of the relief section 61, as shown by a comparison of FIGS. 12 and 15, FIG. 15 showing a typical condition which may be expected at an elevated temperature less than the final fire temperature. Similarly, the relative positions of the flanges 82 and 83 and the rivets 88 and 89 with respect to their respective slots will change, as shown by comparison of FIGS. 12 and 15. The compression stresses in the beam flanges are not relieved and hence the beam flanges buckle downwardly in the area of the space 62, as shown at 90 in FIG. 15.

The greater axial length of the space 64 as compared to the space 63 permits inward movement of the beam web into the relief section 61 without interference from the flanges 79.

The beam will generally be rolled from a flat strip of sheet steel, e.g., of .025 inch thickness. The various holes and slots may be cut in the beam web, as by means of dies, after the beam has been rolled. However, it is difficult to die cut a hole on the line of joinder of the horizontal beam flange and the vertical beam web. Hence, it is desirable to pre-blank in the flat stock portions of the expansion relief sections adjacent the line of joinder between the flanges and the web. Moreover, it is desirable to extend the expansion relief sections slightly into the horizontal flanges as a greater inducement for the flanges to bend downwardly in the area of the expansion relief sections under the compressive stresses accompanying a fire condition.

A short length of beam stock is shown at 91 in FIG. 16. After rolling, the beam flanges will extend from edges 92 and 93 inwardly to imaginary lines 94 and 95, respectively. Aligned holes 96 and 97 are cut adjacent opposite sides of the beam stock, and when the beam is rolled these holes will form the space 62 in FIG. 8. Dimension B at the bottom of space 62 lies along imaginary lines 94 and 95. The holes 96 and 97 have triangular extensions 98 and 99, respectively, which extend into those portions of the stock which will form the beam side flanges. The lateral extent of the triangular extensions 98 and 99 should be relatively small so as not unduly to weaken the beam. For example, if the flanges were to be $1\frac{1}{32}$ inch wide, the triangles 98 and 99 might extend into the flanges about $\frac{1}{8}$ inch. The pre-blanked holes are each generally diamond-shaped. The remainder of the expansion relief section will be cut out after the beam is rolled.

It should be understood that the various dimensions set forth herein are given only by way of example and are not to be taken as limiting the invention.

The construction of the invention is applicable generally to the flanged beams employed in ceiling constructions. For example, in beams with two vertical webs, expansion relief joints would be provided in both webs.

While the invention has been described in connection with specific embodiments thereof and in a specific use, 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 is claimed is:

1. A beam for use in a fire retarding structural system, comprising an upstanding web portion and a horizontal

flange portion, said web portion having an opening forming an expansion relief space extending from said flange through the opposite edge of said beam, said space being positioned intermediate the ends of said beam, said opening having a length taken along the length of said beam selected to accommodate anticipated axial expansion of said web portion upon exposure to a fire to thereby prevent lateral buckling of said web portion, said opening having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said opening between said elongated portion and said flange being convergent toward each other to their line of juncture with said flange to cause buckling of said flange below said opening when said beam is exposed to fire.

2. A beam for use in a fire retarding structural system, comprising an upstanding web portion, a horizontal flange portion, said web portion having an opening forming an expansion relief space extending from said flange through the opposite edge of said beam, said space being positioned intermediate the ends of said beam, said opening having a length taken along the length of said beam selected to accommodate anticipated axial expansion of said web portion upon exposure to a fire to thereby prevent lateral buckling of said web portion, said opening having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said opening said elongated portion and said flange being convergent toward each other to their line of juncture with said flange to cause buckling of said flange below said opening when said beam is exposed to fire, and reinforcing means bridging said opening and being attached to said web portion on opposite sides of said opening, said attachment of said reinforcing means to said web portion permitting relative motion between said web portion and said reinforcing means.

3. A beam for use in a fire retarding structural system, comprising an upstanding web portion, and a flange portion extending laterally from the bottom of said web portion, said web portion having an opening extending from said flange through the opposite edge of said beam at a location intermediate the ends of said beam, said opening having a length taken along the length of said beam selected to accommodate axial expansion of said web portion upon exposure of said beam to a selected elevated temperature characteristic of exposure to a fire thereby to prevent lateral buckling of said web portion, said opening having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said opening between said elongated portion and said flange being convergent toward each other to their line of juncture with said flange to cause buckling of said flange below said opening when said beam is exposed to fire.

4. A beam as set forth in claim 3 in which said opposite sides of said opening between said elongated portion and said flange make an acute angle with the plane of said flange portion.

5. A beam for use in a fire retarding structural system, comprising an upstanding web portion, a flange portion extending laterally from the bottom of said web portion to give said beam an inverted T across section, said web portion having an opening extending from said flange to the opposite edge of said beam, said opening being positioned intermediate the ends of said beam, said opening having a length taken along the length of said beam selected to accommodate axial expansion of said web portion upon exposure of said beam to a selected elevated temperature characteristic of exposure to a fire to thereby prevent lateral buckling of said web portion, said opening having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said opening between said elongated portion and said flange being convergent toward each other to their line of juncture with said flange to cause buckling of said flange below said opening when said beam is exposed to fire, a pair of arcuate reinforcing plates each having a concave

surface facing said web portion on a respective side thereof and each spanning said opening, said web portion having a pair of axially elongated slots on each side of said opening, and means interconnecting said reinforcing plates and said web portion, said last mentioned means comprising a pair of connecting members each rigidly attached to said plates and each acting in a respective one of said elongated slots, the elongation of said slots being sufficient to permit relative motion of said web and said plates in an amount equal at least to said length of said opening.

6. A beam as set forth in claim 5 in which said web portion has an additional pair of axially elongated slots each axially spaced from a respective one of the slots of said first pair and in which an additional pair of connecting members is attached to each of said plates, the additional connecting members each acting in a respective one of said additional slots, the axial length of said additional slots being sufficient to permit relative motion of said web and said plates in an amount equal at least to said length of said opening.

7. A beam for use in a fire retarding structural system, comprising an upstanding web portion, a flange portion extending laterally from the bottom of said web portion to give said beam an inverted T cross section, said web portion having an opening extending from said flange through the opposite edge of said beam, said opening being located intermediate the ends of said beam and forming an expansion relief section, said section having a length taken along the length of said beam selected to accommodate axial expansion of said web portion upon exposure of said beam to a selected elevated temperature characteristic of exposure to a fire to thereby prevent lateral buckling of said web portion, said opening having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said opening between said elongated portion and said flange being convergent toward each other to their line of juncture with said flange to cause buckling of said flange below said opening when said beam is exposed to fire, said axially elongated portion being shaped as a generally flattened diamond, a pair of reinforcing plates each disposed on a respective side of said web portion and each spanning said opening, and means interconnecting said reinforcing plates and said web portion, said last mentioned means permitting axial expansion of said web portion relative to said reinforcing plates.

8. A beam for use in a fire retarding structural system, comprising an upstanding web portion, a flange portion extending laterally from the bottom of said web portion, said web portion having a plurality of axially spaced openings each extending from said flange through the opposite edge of said beam and each being positioned intermediate the ends of said beam, said openings each having a length taken along the length of said beam selected so that the total length of said openings as a group accommodates axial expansion of said web portion upon exposure of said beam to a selected elevated temperature characteristic of exposure to a fire thereby to prevent lateral buckling of said web portion, said openings each having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said respective openings between said respective elongated portions and said flange being convergent toward each other to their line of juncture with said flange to cause lateral buckling of said flange below said openings when said beam is exposed to fire.

9. A beam for use in a fire retarding structural system, comprising an upstanding web portion, a flange portion extending laterally from the bottom of said web portion, said web portion having an opening extending from said flange through the opposite edge of said beam and being positioned intermediate the ends of said beam, said opening having a length taken along the length of said beam selected to accommodate axial expansion of said web portion upon exposure of said beam to a selected elevated

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temperature characteristic of exposure to a fire to thereby prevent lateral buckling of said web portion, said opening having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said opening between said elongated portion and said flange being convergent toward each other to their line of juncture with said flange to cause buckling of said flange below said opening when said beam is exposed to fire, a pair of reinforcing plates disposed adjacent said web on opposite sides thereof and each spanning said opening, said web having a first pair of axially elongated slots disposed on opposite sides of said opening and a second pair of axially elongated slots disposed on opposite sides of said opening and axially spaced from the corresponding slots of said first pair, said plates each having a pair of projections extending into a respective slot of the axially outer pair of slots and being aligned with a corresponding projection of the other plate, said plates each having an inwardly projecting flange extending into said opening and being aligned with the flange of the other plate, the length of said projections and said flanges being selected to maintain a lateral spacing between said plates greater than the thickness of said web, first connecting means acting in the slots of said inner pair of slots for rigidly interconnecting said plates, and second connecting means interconnecting corresponding projections for rigidly interconnecting said plates, the axial extent of said slots being sufficient to permit said expansion of said web portion without interference with said connecting means.

10. A beam for use in a fire retarding structural system, comprising an upstanding web portion and a horizontal flange portion, said web portion having an opening forming an expansion relief space extending from said flange through the opposite edge of said beam, said space being positioned intermediate the ends of said beam, said open-

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ing having a length taken along the length of said beam selected to accommodate anticipated axial expansion of said web portion upon exposure to a fire to thereby prevent lateral buckling of said web portion, said opening having an axially elongated portion intermediate said flange and said opposite edge, the opposite sides of said opening between said elongated portion and said flange each being disposed at an angle with respect to said flange to cause buckling of said flange adjacent said opening when said beam is exposed to fire.

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**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,189,138

June 15, 1965

Henry Znamkowski

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected, below.

Column 4, line 59, after "faces" strike out "of"; column 7, line 75, after "might" insert -- each --; column 9, line 26, after "opening" insert -- between --; line 70, for "oppostie" read -- opposite --.

Signed and sealed this 23rd day of November 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents