



US 20130174500A1

(19) **United States**

(12) **Patent Application Publication**  
**Geller**

(10) **Pub. No.: US 2013/0174500 A1**

(43) **Pub. Date: Jul. 11, 2013**

(54) **SEISMIC RESISTANT GRID CEILING  
SUSPENSION SYSTEM AND METHOD OF  
INSTALLATION**

**Publication Classification**

(75) Inventor: **Alvin Geller**, Ventura, CA (US)

(51) **Int. Cl.**  
*E04B 1/98* (2006.01)  
*E04B 9/00* (2006.01)  
*E04B 9/18* (2006.01)

(73) Assignee: **MARTIN INTEGRATED SYSTEMS**,  
Orange, CA (US)

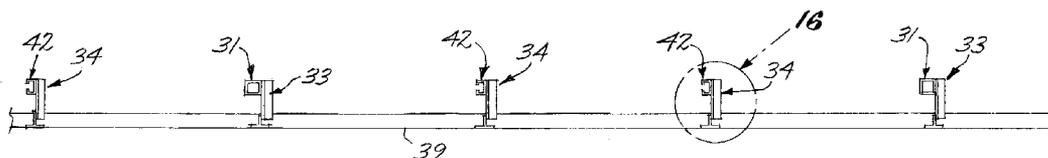
(52) **U.S. Cl.**  
USPC ..... **52/167.1**; 52/506.06; 52/745.05

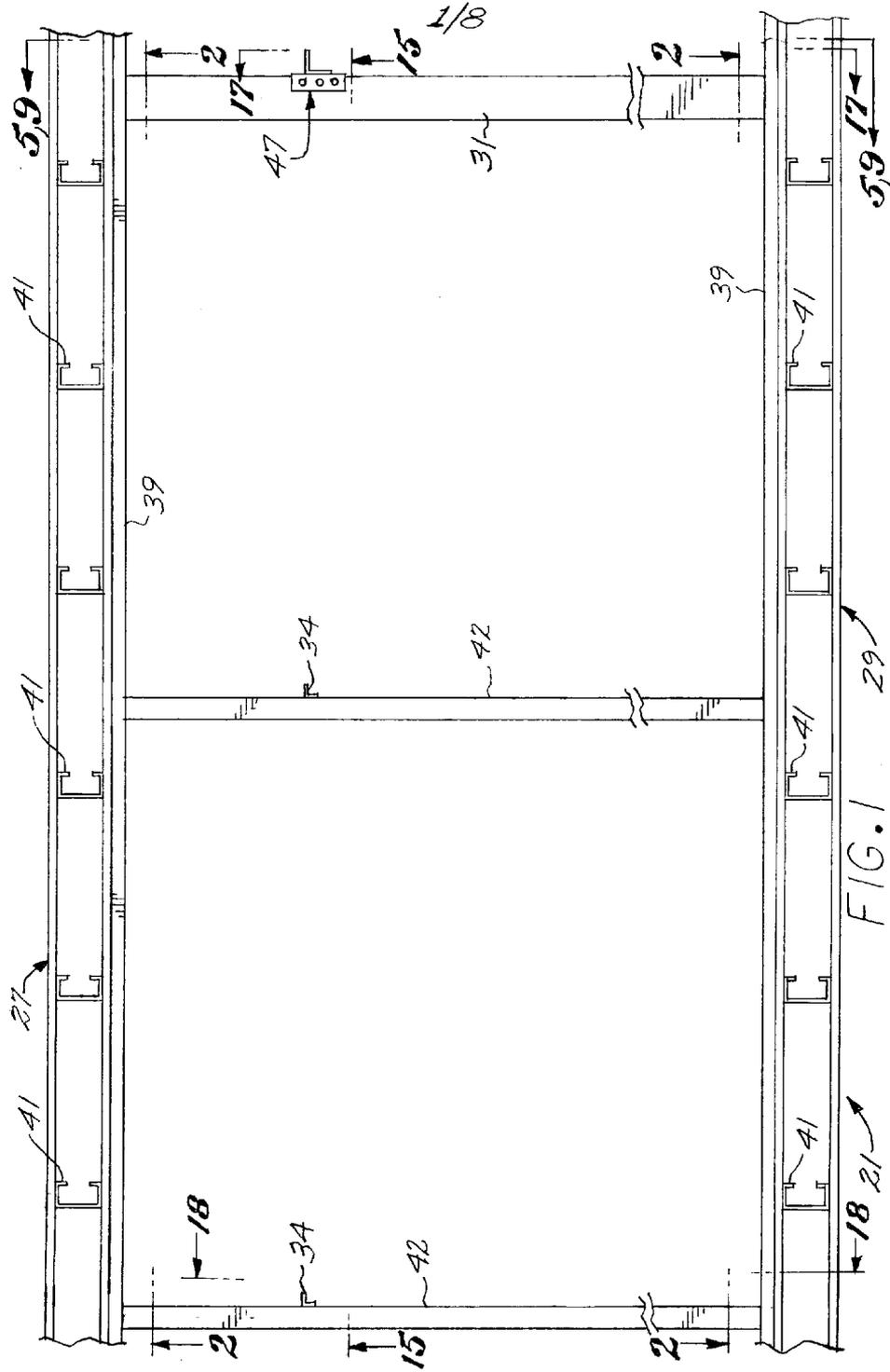
(21) Appl. No.: **13/344,003**

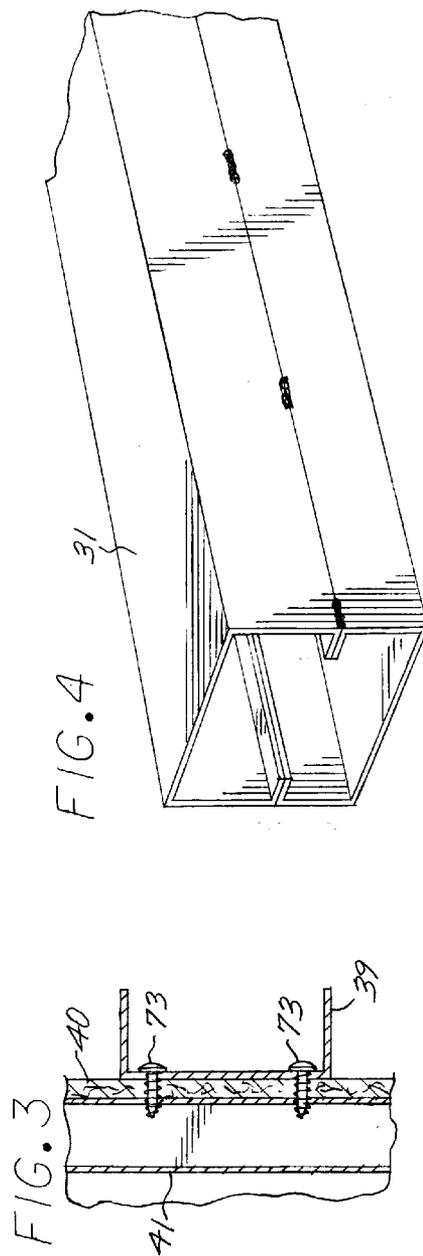
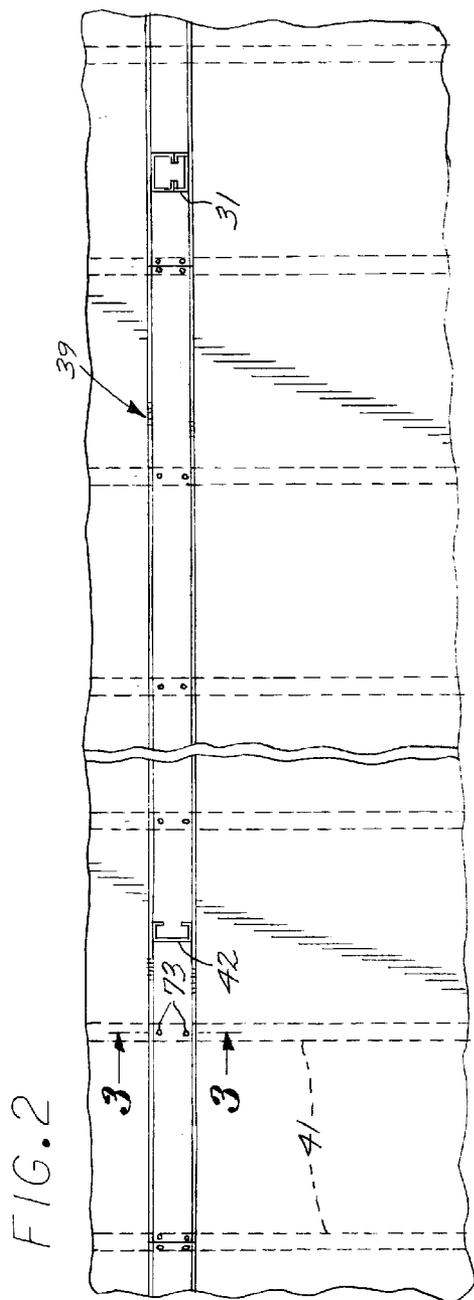
(57) **ABSTRACT**

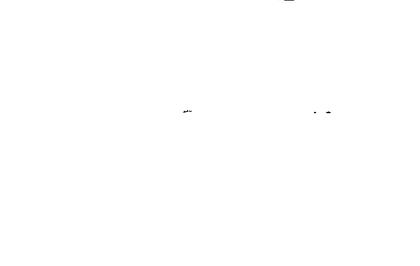
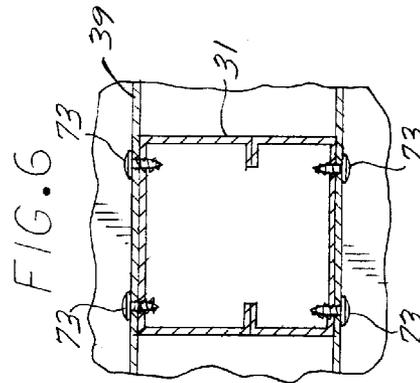
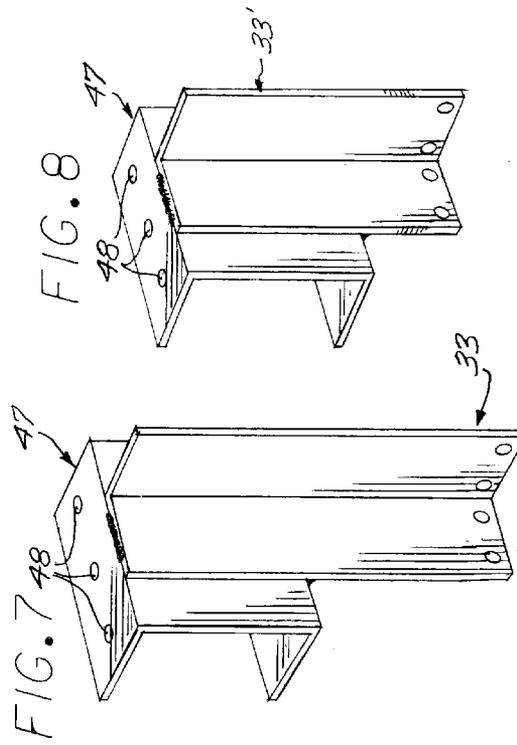
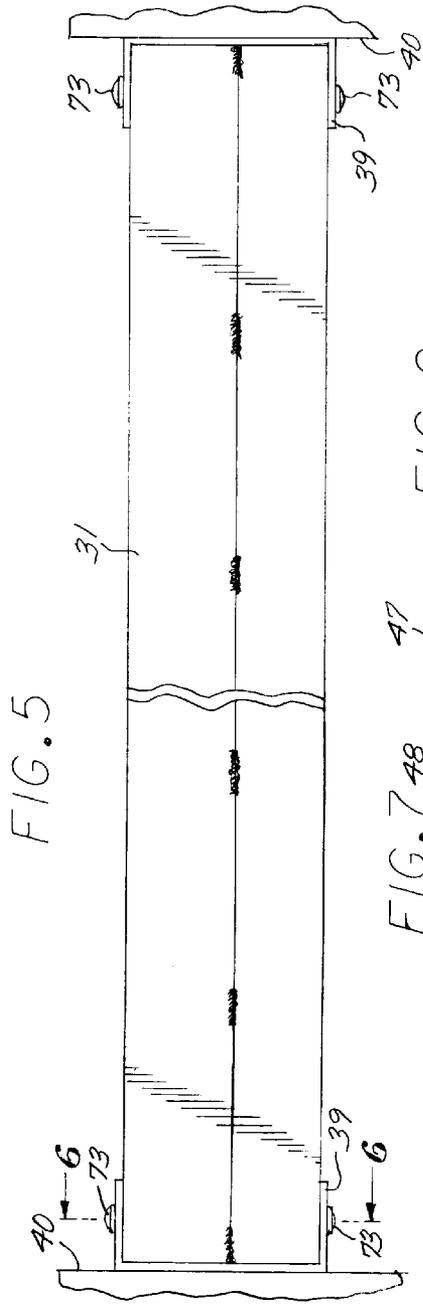
Ceiling suspension system including a plurality of rigid, elongated seismic joists interposed between opposing walls of a room, spaced selected distances apart along a horizontal support plane, and hangers suspended from the respective joists to support a grid from the respective lower ends thereof.

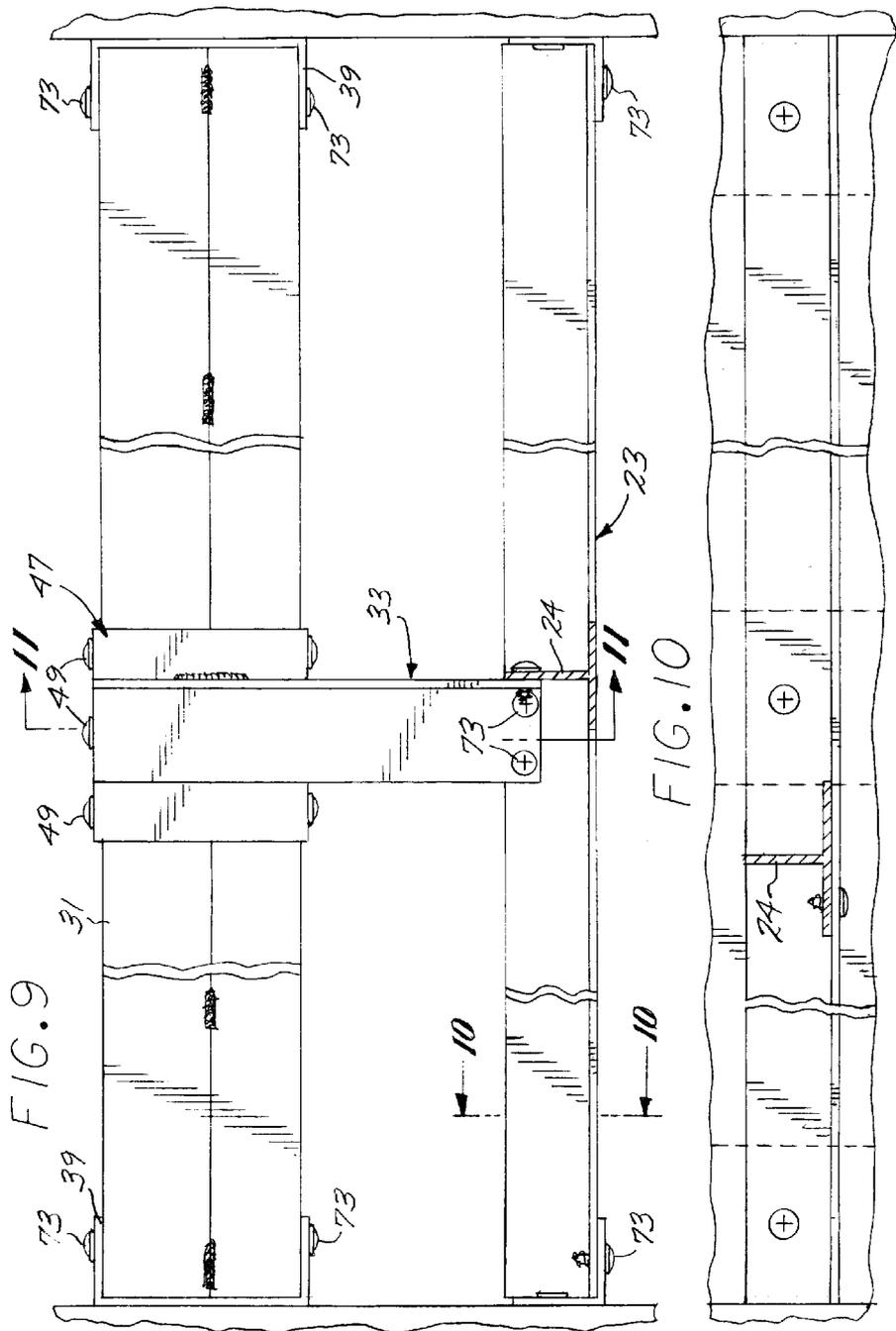
(22) Filed: **Jan. 5, 2012**











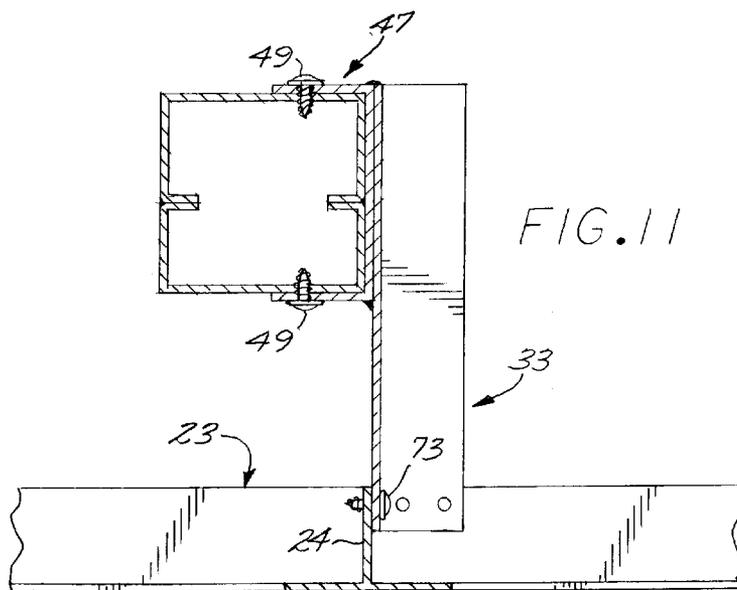


FIG. 12

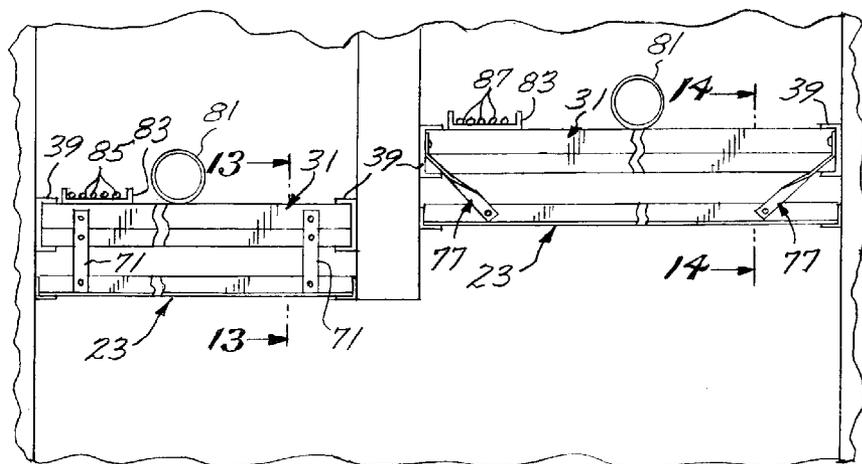


FIG. 13

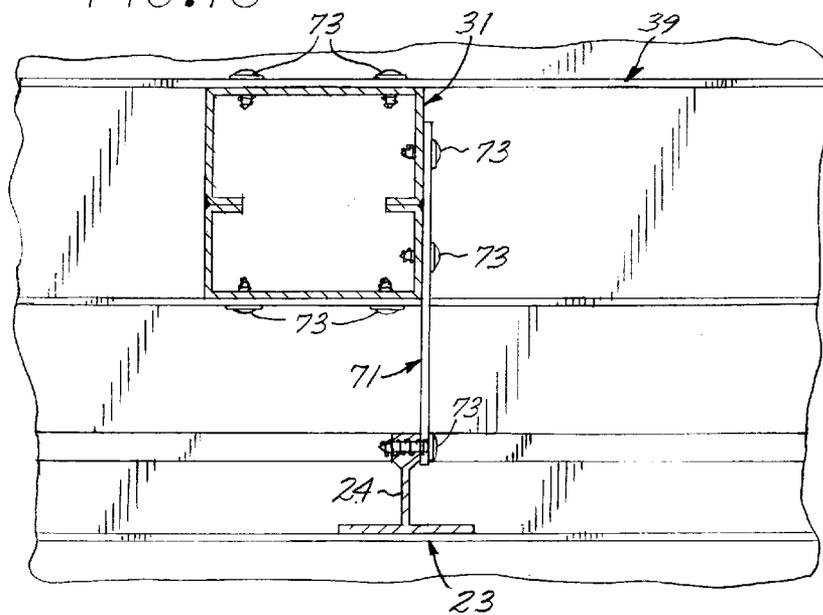
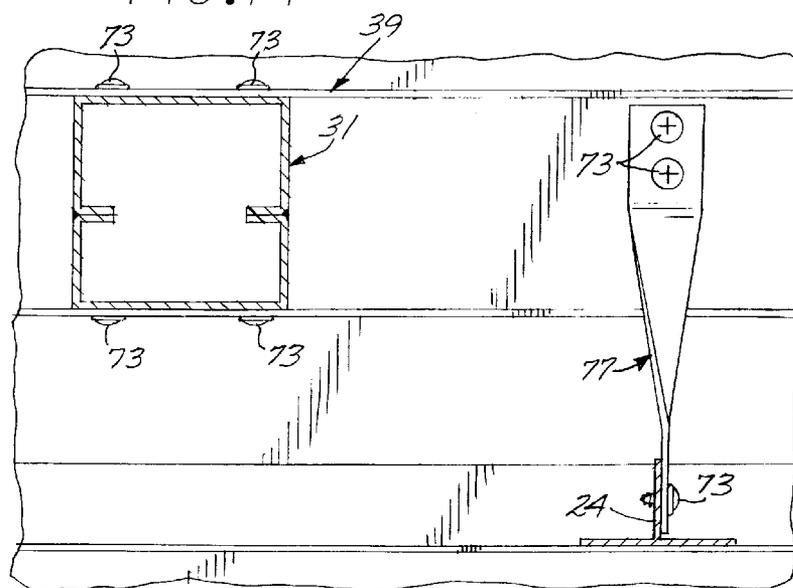
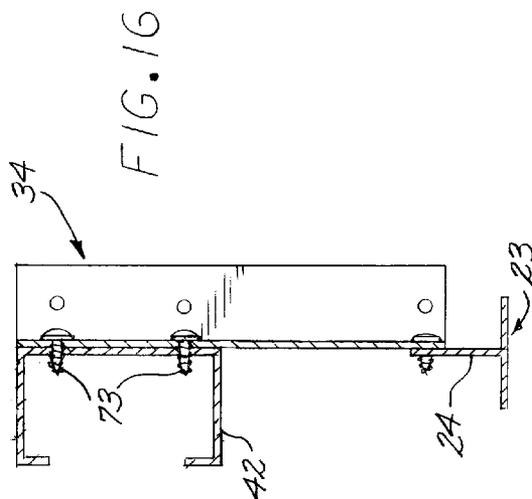
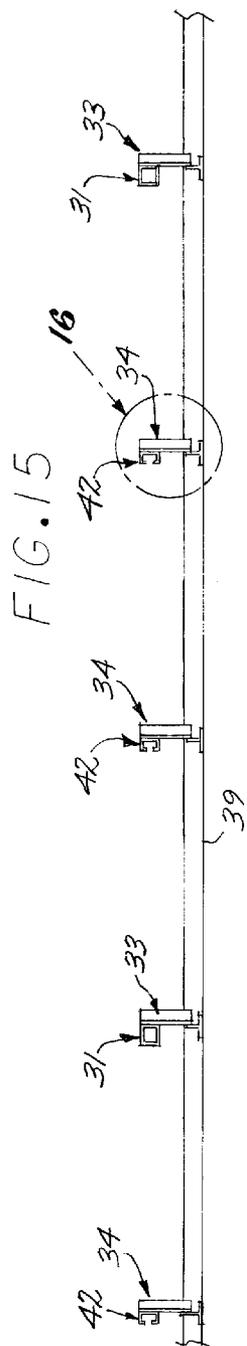
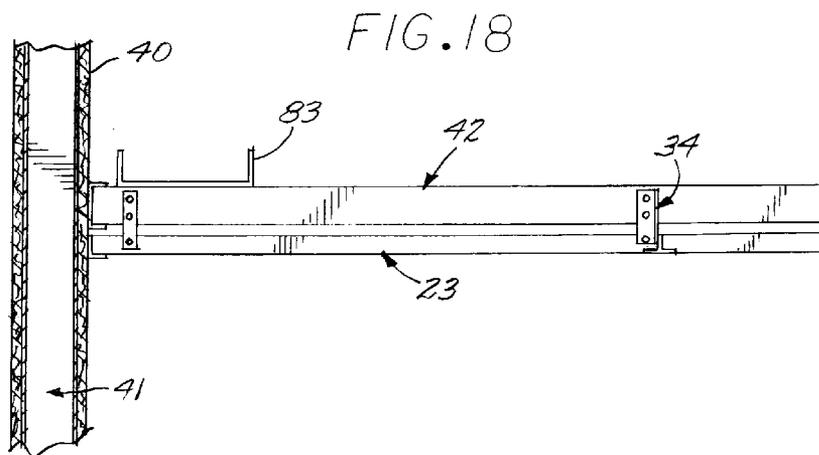
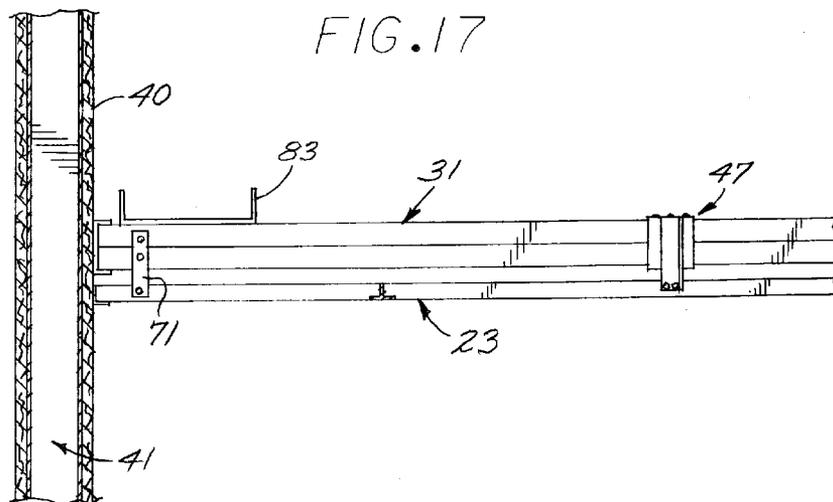


FIG. 14







**SEISMIC RESISTANT GRID CEILING  
SUSPENSION SYSTEM AND METHOD OF  
INSTALLATION**

**BACKGROUND**

**[0001]** 1. Field of the Invention

**[0002]** The present invention relates generally to seismic building construction and suspended ceilings.

**[0003]** 2. Description of Prior Art

**[0004]** Earthquakes propagate pulsating energy waves through the earth which result in vertical and horizontal ground motion. The ground motion rapidly reverses direction and has the greatest ground movement at the beginning of the earthquake, and then slowly decays in intensity. Buildings, supported on the earth by their foundations, tend to follow the ground motion. As the main structure of the building is moved back and forth by the earthquake, other parts of the building will independently respond to the building movements depending upon their stiffness and their mass (weight).

**[0005]** The opposite sides of ceiling grid are typically attached to the opposite walls of a hallway or the like and the grid will tend to move with the walls. It will be appreciated, however that as walls flex differently the grid will be exposed to different forces. It is common to design building structures to limit deflection to a maximum amount equal to the length in inches divided by 360. Thus, for a standard width hallway of eight feet, the allowed deflection is 96/360, or 0.27 inches, such that the center of the ceiling grid would be limited to a translation of 0.27 inches relative to the hallway walls thus serving to limit or eliminate damage to the grid during an earthquake.

**[0006]** Stud walls within a building will flex and bend individually in response to the building's movements. For example, a stud wall with floor and wall-hung cabinets will have higher mass, and thus move differently than a wall without cabinetry. Elongated corridor and hallway ceilings have been severely damaged during seismic events when stud walls on opposite sides of a corridor are flexed and deflected inwardly toward the corridor (crushing the ceiling grid members), or flex outwardly away from the corridor (pulling the attached grid members apart).

**[0007]** Recent building codes require a "slip" joint on one wall in ceiling grid construction, recognizing the independent movement of both the opposing stud walls as well as the movement of the ceiling. The slip joints have been successful for small earthquakes, but are less effective in preventing ceiling damage with larger earthquakes. Most suspended grid ceiling systems are supported on wires attached to the overhead structure. Wire length is often 6 to 10 feet. Seismic splay wires, typically angling at a 45 degree angle to the horizontal, are even longer. The ends of the wires are connected to eye screws attached to the structure and to the grid. The wire is looped through the eye screw or a hole in the grid and then wrapped back upon itself. During seismic events, the ceiling will often shift with the walls and stretch the wire loops to leave them slack. This resultant slack then allows for even greater ceiling translations and potential damage to the ceiling in the event of a subsequent seismic event.

**[0008]** Efforts to address the damage to suspended ceilings have led to a proposal that a rigid strut be inserted between the overhead and ceiling grid work, purportedly to address issues relating to shock waves stemming from earthquakes and the like. A device of this type is shown in U.S. Pat. No. 3,842,561 to Wong. Such devices, while possibly having some benefit,

have failed to provide the desired degree of resistance to grid sway during and succeeding a seismic event, do not address the problem of the opposite walls moving independently and have not been generally accepted in the trade.

**[0009]** Other efforts have focused on the mass of ceiling suspended and have proposed an arrangement for segments of support beams to oscillate longitudinally independent of one another about an interposed gap. A device of this type is shown in U.S. Pat. No. 7,788,872 to Platt.

**[0010]** Still other efforts have led to proposals for a mounting clip to be anchored by fasteners directly to the adjacent wall and having a limited length of overhang for the horizontal leg of the clip. A device of this type is shown in U.S. Pat. No. 7,578,106 to Burns et al. Such devices leave the walls of the room or corridor free to flex independently and damage the ceiling grid and do little to limit translation of the grid relative to the walls.

**SUMMARY OF THE INVENTION**

**[0011]** The suspension system of present invention includes a plurality of elongated torsion and bend-resistant joists interspersed longitudinally between side walls of a room and abutted on their opposite ends to tracks carried from the wall studs thereby tending to maintain the wall spacing in the event of an earthquake. In one embodiment the ceiling grid is suspended from the joists by means of rigid vertical lever arm hangers.

**[0012]** The features and advantages of the invention will be more readily understood from the following detailed description which should be read in conjunction with the accompanying drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**[0013]** FIG. 1 is a broken top plan view showing the grid suspension system of the present invention;

**[0014]** FIG. 2 is a sectional view taken along line 2-2 of FIG. 1 and depicting a track mounted to one of the sidewalls of a hallway from which the suspension system in FIG. 1 is supported;

**[0015]** FIG. 3 is a vertical sectional view, in enlarged scale, taken along line 3-3 of FIG. 2;

**[0016]** FIG. 4 is a perspective view, in enlarged scale, of a seismic joist incorporated in the system shown in FIG. 1;

**[0017]** FIG. 5 is a transverse sectional view, in enlarged scale, taken along the line 5-5 of FIG. 1;

**[0018]** FIG. 6 is a vertical sectional view taken along the line 6-6 of FIG. 5;

**[0019]** FIG. 7 is a perspective view, in enlarged scale, of a lever arm defining a hanger incorporated in the suspension system shown in FIG. 1;

**[0020]** FIG. 8 is a perspective view of a lever arm similar to FIG. 7 but shorter;

**[0021]** FIG. 9 is a vertical sectional view, in enlarged scale, taken along the line 9-9 of FIG. 1;

**[0022]** FIG. 10 is a vertical sectional view taken along the line 10-10 of FIG. 9;

**[0023]** FIG. 11 is a vertical sectional view along the line 11-11 of FIG. 9;

**[0024]** FIG. 12 is a broken vertical view depicting hangers included in the suspension system of FIG. 1;

**[0025]** FIG. 13 is a vertical sectional view, in enlarged scale, taken along the line 13-13 of FIG. 12;

[0026] FIG. 14 is a vertical sectional view taken long the line 14-14 of FIG. 12;

[0027] FIG. 15 is a vertical sectional view taken along the line 15-15 in FIG. 1;

[0028] FIG. 16 is a vertical detail sectional view, in enlarged scale, taken from the circle 16 of FIG. 15;

[0029] FIG. 17 is a vertical sectional view, in enlarged scale, taken along the line 17-17 of FIG. 1; and

[0030] FIG. 18 is a transverse sectional view, in enlarged scale, take line 18-18 of FIG. 1 and showing a joist and hanger arrangement.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] The present invention includes, generally, a suspension system 21 for suspending a ceiling grid 23 from the opposite walls 27 and 29 of a corridor, room or the like. The system 21 includes robust, transverse seismic joists, generally designated 31, interposed between the walls, spaced selected distances apart along the corridor and supported on their respective opposite ends from tracks mounted to the wall studs. For the purposes of my invention the term “seismic joist” is intended to mean a joist mounted over a room or hallway to opposed walls and constructed to resist the ceiling seismic forces and relative movement of the walls. In one preferred embodiment the grid 23 is suspended from the joists 31 by means of rigid vertical lever arms defining respective hangers 33 spaced apart laterally along the respective joists and configured to provide a substantial degree of rigidity and stiffness to restrict movement of the grid work 23 relative to the joists 31 and surrounding structure.

[0032] In a preferred embodiment, I have elected to support my system 21 from a pair of longitudinal, inwardly facing, channel-shaped tracks 39 which I abut against the drywall 40 (FIG. 3) and fasten directly or indirectly to the vertical studs 41 framing the opposite sidewalls of the corridor, as by #10 TEK screws (FIG. 3). The studs form no part of the present invention and may be conventional 16-gauge C-channels. I construct my tracks 39 of 3 $\frac{3}{8}$  by 1 $\frac{1}{4}$  inch 20-gauge stud channels to form inwardly facing nesting cavities for the opposite ends of the respective joists. The ends of the joists 31 are received slidably in close fit relationship in the open sides of the tracks 39 and may be fastened thereto by, for instance, #10 TEK screws, top and bottom (FIG. 5).

[0033] For the seismic joists 31, it is important that they have relatively low weight-to-load-carrying capability so as to provide substantial resistance to the bending and torque loads applied thereto as the walls tend to shift relative to one another. For the joists of my preferred embodiment, I have selected box beam construction to be constructed of readily available 18-gauge steel C-channels with the opposite flanges abutted against one another and formed with seamed welds spaced there along at 12 inch intervals to form a tubular construction. In this exemplary embodiment, I have selected to install my system over a corridor approximately 12 feet wide, and accordingly, the seismic joists are approximately 12 feet long. I have determined that, to meet building codes and provide for satisfactory construction in earthquake zones such as Southern California, the seismic joists can be spaced along the corridor at intervals of 8 to 16 feet or the like for particular applications. As will be appreciated, other spacing and constructions will be determined by the particular structural ceiling width and code(s) to be met. Other construction for the respective seismic joists would include hexagonal or

cylindrical tubes or square tubes such as a 4-inch by 4-inch steel tube, but such tubing typically comes in 11-gauge thickness, rendering it more challenging for applying fastening screws thereto. Ideally, a 16- or 18-gauge 3 $\frac{3}{8}$ -inch square tube would have particularly satisfactory application, it only being important for this invention that the seismic joists provide the desired resistance to torque and bending loads applied thereto by the suspended ceiling during a seismic event. In this regard it will be appreciated that the beam characteristics of a hollow tubular-type joist with the walls thereof spaced some distance from the axial center of the beam exhibit a relatively high resistance to torque and bending but other satisfactory configurations will occur to those of skill.

[0034] In the preferred embodiment, the seismic joists are spaced along the respective walls 27 and 29 at 16-foot intervals. For ceiling support between the respective seismic joists, I provide conventional C-channel support joists 42 nested on their opposite ends within the respective opposed tracks at 4 foot on center spacing to thus cooperate in supporting the grid.

[0035] Hangers 34 (FIGS. 15 and 16), comparable to the hangers 33, carried from such joists will cooperate in supporting the weight of the grid. In the preferred embodiment, the lever arms defining the hangers 33 are constructed of 2-inch by 2 $\frac{1}{2}$ -inch 16 or 18-gauge steel angle to resist bending and are connected on their upper extremities to the respective joists 31 or 42, by means of rectangular C-channel mounting brackets 47 welded to the hangers and configured to engage in close fit relationship over top and bottom sides of the respective joists and are fastened to the joists by self tapping fastener screws 49 such as #10 TEK screws inserted through pre-drilled bores 48 to provide a slack-free connection. For the purposes of my invention, a “slack-free connection” is a connection where there is no relative movement between the parts once the connection is made.

[0036] For the purposes of my invention, “rigid hanger” is defined as a strap, angle, tube or bar, constructed to be less flexible than conventional ceiling hanger wires to, in practice, resist relative movement between a joist and ceiling grid.

[0037] It will be appreciated that the hanger lever arms act as relatively rigid hangers to resist relative movement between the respective joists 31 and the grid 23 without the necessity of any supplemental type of bracing or splay wires. In practice, these lever arms or hangers 33 are spaced laterally apart toward the opposite sides of the corridor and may be sufficiently long to suspend the grid 23 a distance below the joists to provide a central, unobstructed plenum chamber 51 of ample volume within the area above the false ceiling. Such a plenum chamber is beneficial to provide convenient space for ready access for workmen to install various equipment typically necessary for efficient construction, such as electric cable trays, various types of medical equipment, plumbing pipes, fire sprinklers, TV screens, projectors and the like, some of which might be supported in horizontal electric wire cable trays supported from the system itself. It will be appreciated that without my invention, these components could add to the mass of the ceiling, and to any acceleration forces should the gridwork be free to sway on flexible wires, thus exacerbating the potential damage inflicted by earthquake activity resulting from rapid acceleration and relative movement between the ceiling grid work and surrounding structure.

[0038] Referring to FIGS. 1, 12, 13 and 14, at various locations there may be different means for supporting the grid work. Referring in particular to FIGS. 12 and 13, the opposite sides of the grid may be nested in upwardly facing angles mounted to the opposite walls and the hanger from the seismic joists 31 and 42 near the opposite sides of the grid may be in the form of vertical metal straps 71 connected to the joist by means of self-tapping screws 73 screwed into pre-drilled bores along one wall of the joist. Then, on the bottom extremity, the strap 71 is connected to the vertical flange of a T-flange 24 by means of a self-tapping screw 73 screwed into such flange.

[0039] Referring to FIG. 14, in this arrangement, the vertical flange 24 at the end of the grid 23 is attached directly to the track 39 by means of downwardly and inwardly angled, twisted strap 77 utilizing a self-tapping screw 73.

[0040] For different heights and elevations, it will be appreciated that the vertical hangers 33 will be configured of different lengths, such as the hanger 33' shown in FIG. 8, which has a length below the top of joist 31 of approximately five inches, as compared to the bracket 33 having a length below the top of joist of about 11 inches. As will be appreciated by those skilled in the art, these lengths will be determined by an analysis of the construction of the building intended to receive the support system and depending on the height of the plenum area above the suspended ceiling which is to be dedicated to various devices and component for conveyance of electrical current, fluids and pneumatics, and the like. In practice, I have found that a plenum height in the area of between 6 and 12 inches is sufficient for most applications.

[0041] It will be appreciated that, with the instant invention, the engineer or designer will typically have access to architectural drawings and blueprints to determine the width and length of the hallway or room, weight and construction of the corridor walls, the intended height of the suspended ceiling, and specifications on the size and weight of the grid work and ceiling panels to be supported, as well as building code for seismic requirements in the area of the intended installation. He or she can then determine the contours of the space available for installation, and determine the length, size and configuration of joists required to carry the bending and torque loads expected to be applied due to loads placed on the respective walls during a seismic event.

[0042] As set forth above, I have discovered that for my particular application, conventional metal construction is desirable with the various gauges and sizes described above. It is intended, however, that the scope of this invention will be defined by the appended claims and that from this disclosure other gauges, configurations and materials will be apparent for various applications.

[0043] In any event, working from this disclosure, architects, engineers and designers will have the details of the construction available from which they can complete the design work for the particular applications. In various sections of the building, depending on height, transitions and the like, the horizontal plane(s) for the joists and for the suspended ceiling will be determined and the hangers selected and fabricated to accommodate those various vertical distances between the various planes. I have found that there is benefit to constructing the support joists, seismic joists, hangers and mounting brackets in a production line, and in most instances locating and pre-drilling the mounting holes for the

mounting fasteners such as screws to thereby expedite the installation task and keep the skill required of the installing technicians to a minimum.

[0044] Thus, as will be apparent from the following, the system may be conveniently and quickly installed without the necessity of accessing the ceiling area for mounting the upper ends of suspension wires or the tedious anchoring of the wire ends, looping and twisting and, in the end, resisting damage to the ceiling components in the event of an earthquake. The system can be rapidly installed to then make the installation area available for others in the trade for installation of plumbing, electrical and ductwork and the like, thus contributing to the efficiency of construction. While the sequence of installation is not important to this invention, I will describe one possible sequence, recognizing that other sequences may be followed without departing from the spirit of the invention.

[0045] In this regard, it will be appreciated that the installers can efficiently position the respective channel tracks 39 in a selected horizontal plane abutted against the drywall 40 and facing toward one another from the opposite walls of a corridor, drill holes in alignment with the respective studs, and install screws 73 to mount the tracks to the respective studs (FIG. 3).

[0046] Sections of the track 39 may be abutted longitudinally together as shown in FIG. 2 and a splice 60 inserted and the respective marginal ends of the sections screwed thereto by means of mounting screws 73 received in pre-drilled bores.

[0047] Referring to FIGS. 1, 9, 15 and 16, the grid for the ceiling may then be moved into place at the desired height spaced below the plane of the tracks.

[0048] The opposite ends of the respective support and seismic joists 42 and 31 may then conveniently positioned in close fit relation to the open sides of the respective tracks 39, holes drilled and mounting screws 73 screwed in such track and joists (FIG. 5), to thereby secure the joists closely fitted in the tracks to provide support against shifting and twisting relative to such track.

[0049] The workmen may then select the hangers 33 and 33' and cut them to the respective desired lengths to be mounted to the respective joists 31 by fitting the brackets 47 over the sides of the respective joists 31, locating over the respective angles in the ceiling grid and inserting the mounting screws through the pre-drilled holes in such brackets (FIG. 9), with the hangers 33 or 33' aligned over the grid. The mounting screws 73 may be inserted through the pre-drilled holes in the lower extremities of the hangers and vertical flanges of the grid to make a positive movement free connection. The straps 71 and 77 (FIGS. 13 and 14) may then be installed as described to provide additional support for the grid. Straps and angles may then also be mounted to the joists 42 to provide further support for the grid (FIG. 11).

[0050] With this stage of construction completed, the workmen may proceed with installing components in the plenum chamber above the suspended ceiling, such as air ducts 81, conduit trays 83 and electrical conduits and the like (FIG. 12). As will be appreciated by those skilled in the art, heavier components such as the air ducts are separately suspended from overhead. The placement of ceiling panels, grates and registers, lighting panels and the like on the grid work will likewise be scheduled at the option of the contractor. As will be appreciated by the artisan, the weight of the ceiling panels and components in total mounted on the gridwork may be

considerable, thus combining to generate considerable momentum to apply considerable loads to the hangers in the event of a seismic event.

**[0051]** When the entire installation is complete and the building construction has passed inspection, the building will be ready for occupancy, the quarters and hallways will be available for foot and cart traffic and the like, and the air ducts **81** and various conveyance cables **85** and **87** will be available for transmission of fluids, pneumatics, electrical signals and the like. It will be appreciated that in many buildings this requirement for conveyance of fluids and signals in the plenum chamber above the suspended ceiling is considerable, thus exhibiting a demand for a relatively high volume plenum chambers and for a suspension system having rather robust support capabilities and resistance to unwanted relative shifting of opposing walls during earthquakes.

**[0052]** In this regard, it will be appreciated that in the unfortunate event of an earthquake, one will expect that the building will be shifted oftentimes tending to impart somewhat independent movement to the hallway walls as the opposing walls tend to shift, flexing portions thereof toward or away from one another. It will be appreciated that such tendency of the walls to flex relative to one another will be resisted by, for instance, as the walls tend to flex toward one another, the column strength of the joists **31** and **42** acting against the respective tracks **39** to thus avoid crushing the grid or pulling the grid apart.

**[0053]** Also, to the extent there is any actual translation of the joists **31** and **42**, the hangers will tend to shift the ceiling grid in unison therewith and will tend to maintain a rigid, motion free connection with such ceiling grid to resist relative movement to thus avoid the ceiling moving independently and crashing into the adjacent walls and administering damage to the drywall and the like thereby tending to minimize the degree of repair work to be completed after the earthquake.

**[0054]** In this regard it will be understood that the cantilever actions of the hangers that tends to shift the ceiling grid with the joists will, upon rapid shifting, apply considerable torque to the joist as resisted by the mounting brackets **47** closely fit over the joists as well as the angular cross section of such hangers thereby applying torque to the joists. Rotation of the joists about their own longitudinal axes is resisted by the nesting of the separate ends thereof in close fit relationship in the open sides of the respective tracks **39** to thus take advantage of the rigid elongated tracks anchored to the wall studs.

**[0055]** From the foregoing, it will be apparent that the present invention provides an economical and convenient means for suspending a drop ceiling from opposing walls in a manner which will resist damage from earthquakes and the like and which in some embodiments also affords the benefit of providing a relatively unobstructed plenum area above the suspended ceiling for conveyance of air ducts, electrical fluid, pneumatic components and the like. My method of manufacture and installation provides for economical manufacture and rapid and convenient on site installation.

**[0056]** The invention may be embodied in other forms without departure from the spirit and essential characteristics thereof. The embodiments described therefore are to be considered in all respects as illustrative and not restrictive. Although the present invention has been described in terms of certain preferred embodiments, other embodiments that are apparent to those of ordinary skill in the art are also within the

scope of the invention. Accordingly, the scope of the invention is intended to be defined only by reference to the appended claims.

I claim:

**1.** A seismic vertical support suspension system for suspending a ceiling grid from the opposite walls of a room or corridor spaced a predetermined distance apart comprising:

a suspension system mounted to the walls including a plurality of transversely projecting seismic joists interposed between the walls to maintain them spaced the predetermined distance apart and spaced predetermined distances apart along a longitudinal horizontal plane and including respective opposite ends abutting the walls;

fastener devices anchoring the opposite ends of the joists to the respective walls;

a plurality of substantially rigid lever arms projecting downwardly from the respective joists and connected on their respective lower extremities of the grid to act as hangers; and

the joists and hangers being so constructed and configured as to, upon a seismic event applying forces to the walls tending to shift such walls relative to one another, maintain the walls spaced the predetermined distance apart.

**2.** The suspension system of claim **1** that includes: motion-free joints connecting at least some of the hangers to the grid.

**3.** The suspension system of claim **1** that includes: support joists interposed between the respective seismic joists; and

hangers suspended from the respective support joists and connected to the grid.

**4.** The suspension system as set forth in claim **1** wherein: the hangers include steel angles, flat steel straps, and twisted steel straps.

**5.** The suspension system as set forth in claim **1** wherein: the hangers include straps.

**6.** The suspension system as set forth in claim **5** wherein: at least some of the straps are twisted.

**7.** The suspension system as set forth in claim **1** wherein: the hangers are constructed with a length below the top of the respective seismic joists of between about 5 and 11 inches.

**8.** The suspension system as set forth in claim **1** wherein: the hangers are spaced apart disposed toward the opposite extremities of the respective joists and cooperate with respective joists and grid to form a relatively unobstructed plenum chamber between such joists and the grid.

**9.** A system for supporting a ceiling grid from the sidewalls of a longitudinal corridor comprising:

horizontal C-channels defining tracks mounted along the respective sidewalls and opening toward one another;

tubular seismic joists interposed between the tracks, spaced apart selected distances along the respective tracks and configured with the respective opposite ends nested in the respective tracks;

rigid metal angle straps connected to the respective seismic joists to suspend the grid work therefrom; and

the joists, hangers and grid being configured to form a substantially unobstructed plenum chamber projecting longitudinally over the grid work.

**10.** The apparatus of claim **9** that includes: support joists spaced along the tracks, interposed between the seismic joists and formed with respective opposite ends nested in the respective tracks; and hangers connected to the respective support joists to cooperate in supporting the grid.

**11.** The apparatus of claim **9** wherein: the seismic joists are constructed of metal having a cross-section of at least  $3\frac{5}{8}$  inches by  $3\frac{5}{8}$  inches.

**12.** The apparatus of claim **9** wherein: the hangers are constructed to support the grid work spaced between 6 and 12 inches below the top of their joists.

**13.** The apparatus of claim **9**, wherein: the hangers are in the form of flat or twisted straps or angles.

**14.** The apparatus of claim **9**, wherein: the seismic joists are constructed of box beams.

**15.** The apparatus of claim **9**, wherein: the seismic joists are spaced apart a distance of substantially 8 to 16 feet.

**16.** The apparatus of claim **9**, wherein: the support joists are spaced apart a distance of 4 feet.

**17.** The apparatus of claim **9**, wherein: the tracks are constructed of  $3\frac{5}{8}$ -inch by  $1\frac{1}{4}$ -inch, 20-gauge C-channels.

**18.** The apparatus of claim **9**, that includes: support joists constructed of C-channels and interposed between the seismic joists; and hangers suspended from the support channels and connected to the grid.

**19.** A method of making and installing a suspension system for supporting a ceiling grid in a horizontal grid plane over a room and including:

selecting tracks to be positioned in a horizontal support plane spaced above the grid plane mounted to opposite walls of the room;

selecting seismic joists of a length to extend between the tracks when mounted to the respective walls;

selecting rigid lever arms to support the grid and of a length sufficient to, when the joists are positioned in the support plane, position the grid in the grid plane;

configuring and sizing the joists and hangers with a configuration to, when installed, dispose the grid in the grid plane;

at a construction site, mounting the tracks to the respective walls in the support plane;

interposing the joists between the tracks;

fastening the joists to the tracks;

positioning the hanger devices on the respective joists; and selecting and inserting threaded fasteners through the joists and hangers.

**20.** The method of claim **19** that includes:

selecting the joists constructed of tubes.

**21.** The method of claim **19** that includes:

selecting the fasteners of self-tapping screws.

**22.** The method of claim **19** that includes:

selecting the joist of a box beam construction.

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