Nov. 10, 1970 J. F. McDERMOTT 3,538,659

BUILDING CONSTRUCTION

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FIG. 1

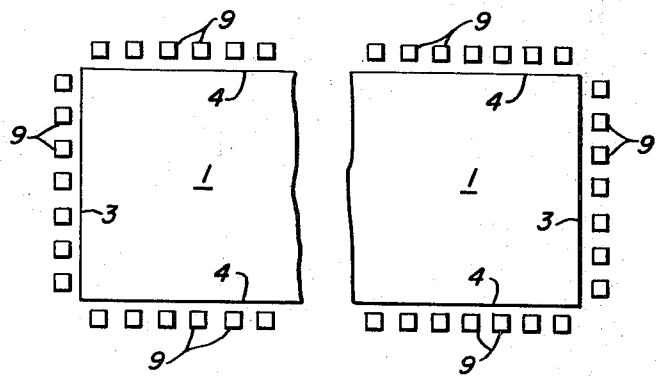


FIG. 6

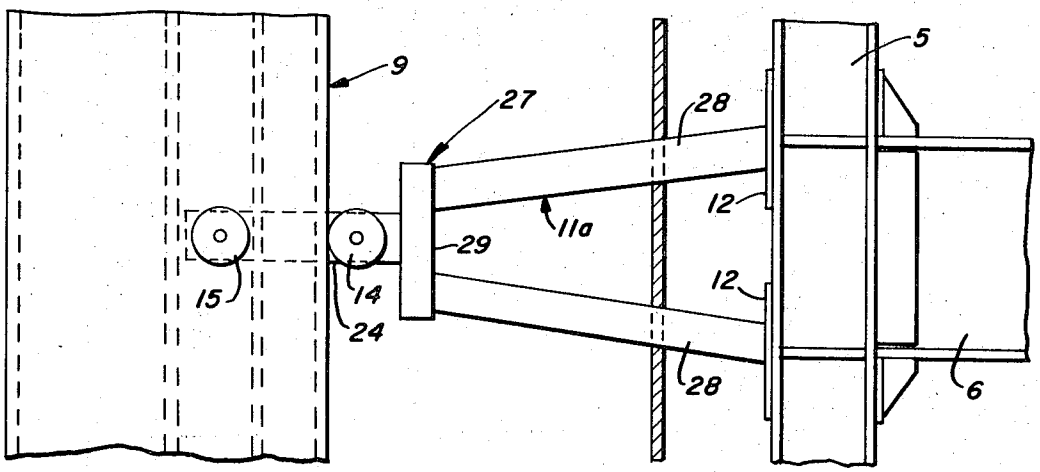
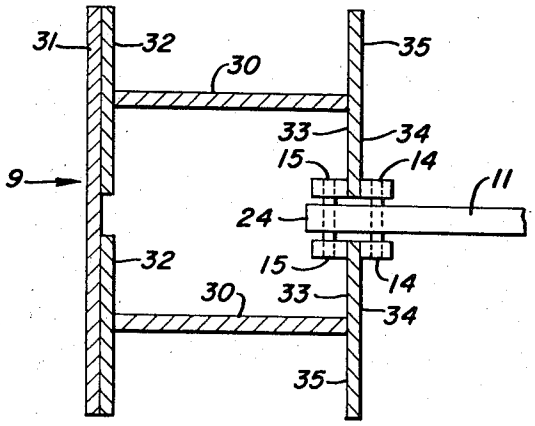


FIG. 7



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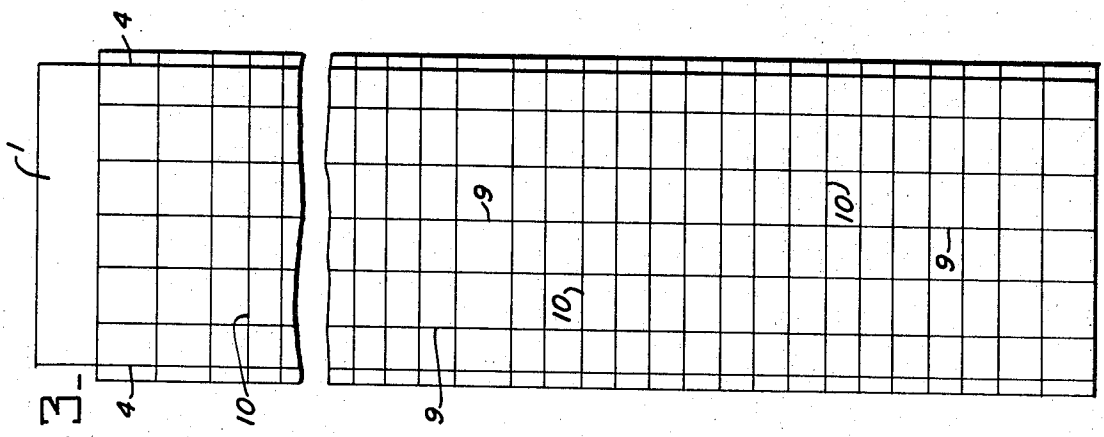


FIG. 3

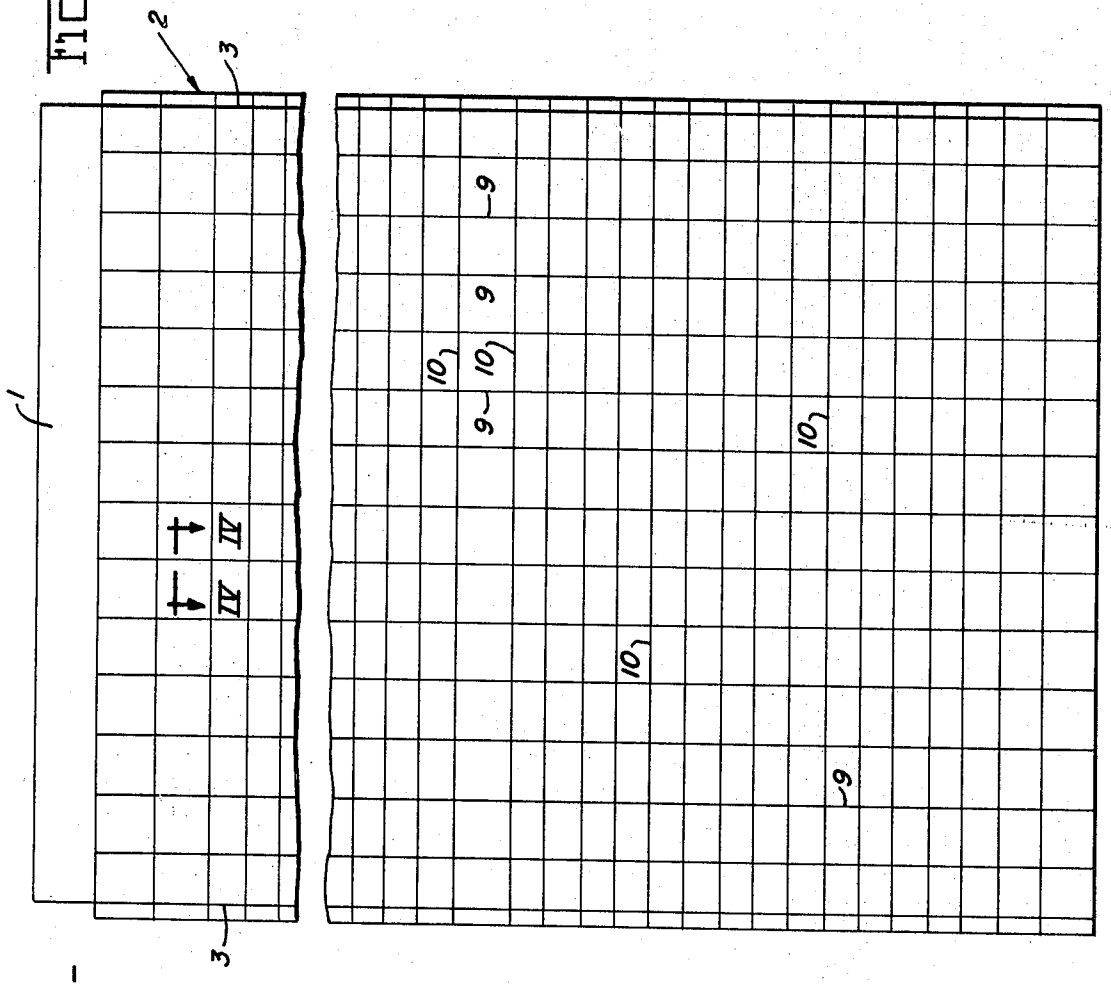


FIG. 2

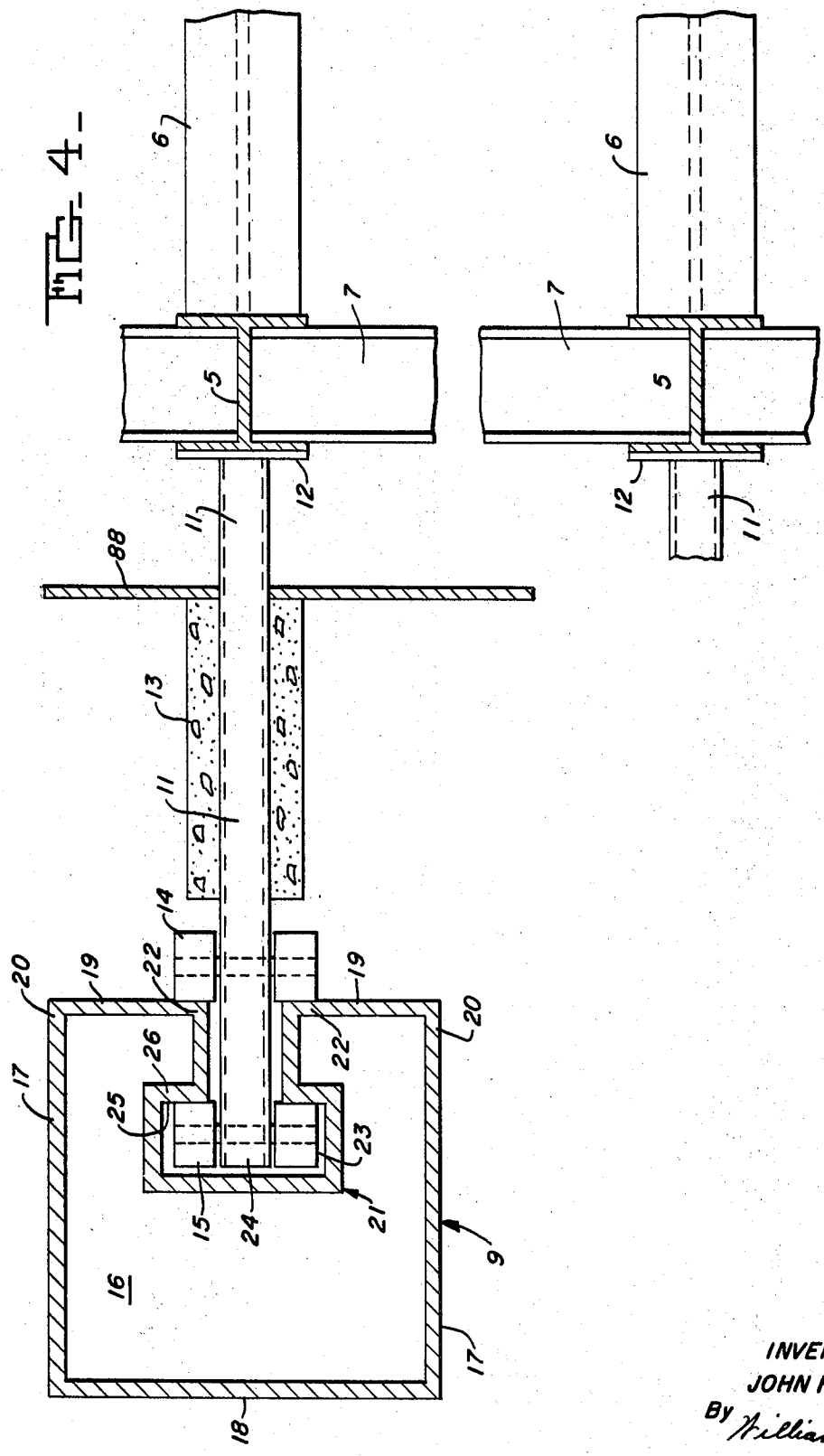
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BUILDING CONSTRUCTION

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FIG. 4



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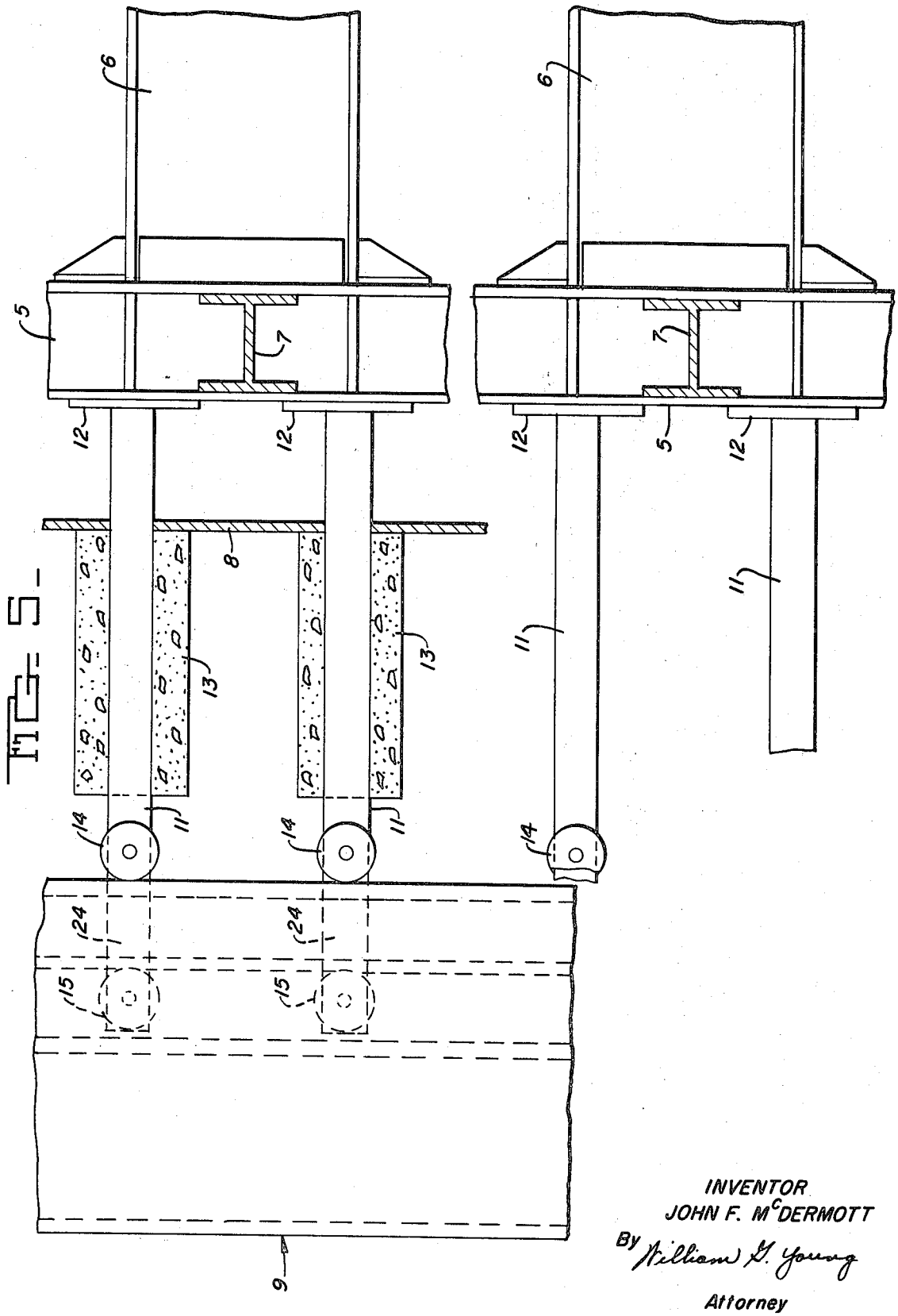


FIG. 5

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3,538,659

BUILDING CONSTRUCTION

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Filed Sept. 19, 1968, Ser. No. 760,802
Int. Cl. E04h 9/00; E04b 1/34, 1/36
U.S. Cl. 52—236 10 Claims

ABSTRACT OF THE DISCLOSURE

A building construction having an interior steel framework and external supports for bracing it against lateral forces and displacements to thereby enable the use of smaller interior columns in said framework, which need be only of sufficient size to support the weight of the building and its contents. The external supports extend generally parallel to the building walls, usually in a vertical or nearly vertical direction, and are spaced peripherally about the base of the building and outwardly with respect thereto. The interior steel framework and the exterior supports are connected by horizontal struts which operate to transmit to the exterior supports those forces which would otherwise result in bending movement of the building, at least one of the connections at opposite ends of the horizontal struts being operative to provide for relative vertical movement of the external supports and the interior steelwork of the building in response to unequal thermal expansion thereof.

This invention relates to a building construction, and to improvements which are designed to increase the available working space in the building. In a manner to be described, the invention resides in an exterior steel framework for bracing a building against lateral bending movement so that the interior steel framework of the building may be fabricated with steel columns of a size sufficient only to support the weight of the building and its contents.

In modern steel-reinforced buildings, the steel framework must have sufficient strength to support both the weight of the building and its contents, and to resist bending as the result of forces and displacements generated by wind, earth tremors, and unbalanced loads that are not equally distributed over the floors of the building. The strength for these purposes is customarily provided by steel columns, frequently with lyateral bracing, with the columns and bracing usually located within the exterior walls of the building. Building constructions have also been proposed in which external steel columns are located outside the walls of the building for supporting the load of the building and for holding it against bending movement, the floors and walls of the building in such constructions being suspended on the exterior steel columns.

In accordance with the principles of this invention, separate structural components are provided respectively for supporting the load of the building and its contents, and for resisting forces produced by wind, earthquakes and non-uniform or unbalanced loading that would result in lateral bending movement of the building. In a manner to be described, the structural compoents for supporting the load of the building and its contents are located within the exterior walls of the building, while the structural components for bracing the building against bending movement are free of the load of the building and are located externally thereof. By physically separating the structural components of the building in this manner, the size of the steel columns in the interior steel framework of the building is materially reduced, and the available floor space is correspondingly increased.

More specifically, the exterior steel structural components of this invention comprise extending steel supports, generally parallel to the building walls, usually in a vertical or nearly vertical direction, which are arranged in positions that are spaced about the periphery of the building and outwardly with respect thereto. Such supports are effective through horizontal struts for holding the steel framework of the building against lateral forces (such as from wind) and displacements (such as caused by earthquakes). According to a further object of the invention, the connections at opposite ends of the horizontal struts with the building and with the exterior vertical supports provide for relative vertical movement of such supports and the interior steel framework of the building in response to unequal thermal expansion therof. A further and related object of the invention is to provide vertically or nearly vertically-extending supports about the exterior of the building, which are free of the weight of the building, but are otherwise effective to brace it against lateral forces and displacements.

Other objects and advantages of the invention will become apparent from the following description and the accompanying drawings, in which:

FIG. 1 is a diagrammatic plan view showing the arrangement of the vertically-extending supports of this invention about the exterior of a building;

FIGS. 2 and 3 are diagrammatic side and end elevational views illustrating the arrangement of the external steel supports of this invention with respect to a building, a central portion of such building constituting several floors thereof being broken away;

FIG. 4 is a fragmentary and horizontal sectional view taken along the line IV–IV of FIG. 2;

FIG. 5 is an elevational view of the structure shown in FIG. 4;

FIG. 6 is a view, similar to FIG. 5, showing a modified form of strut for connecting the framework of the building with the exterior bracing supports; and

FIG. 7 is a fragmentary sectional view, similar to FIG. 4, showing a modified form of vertically-extending support.

The building construction of this invention, as shown diagrammatically in the drawings, comprises a building **1** which is braced against lateral forces and displacements by an external steel reinforcement or framework **2**. The building **1** is rectangular in shape and has laterally-spaced end walls **3** and laterally-spaced side walls **4** as shown in FIGS. 2 and 3 of the drawings. As shown in FIGS. 4 and 5, the building **1** is constructed with interior vertical steel columns **5** which are arranged in spaced positions along the walls **3** and **4** of the building and are held in spaced relation by horizontally extending transverse girders **6** at each of the floors of the building, and by horizontal spandrels **7** between the girders **6**. The columns **5**, girders **6** and spandrels **7** form the interior framework of the building on which a curtain or other wall **8** of conventional construction is supported.

The exterior steel framework **2** comprises vertically-extending steel supports **9**, which have their lower ends (not shown) anchored in and supported by the building foundation, the supports **9** being arranged in positions spaced about the periphery of the building **1** and outwardly with respect thereto as best shown in FIG. 1. Adjacent pairs of the supports **9** are preferably connected by horizontal spandrels **10** in the form of steel beams having suitable rigid connections at opposite ends thereof with the supports **9**. The spandrels **10** are preferably provided opposite each of the floors of the building, but it will be understood that a different vertical spacing of the spandrels **10**, for example, at alternate or selected ones of the floors of the building, may be em-

ployed if desired. The supports **9** and spandrels **10** form the exterior steel framework **2**, which serves only in a manner to be described to support the building **1** against lateral bending movement as the result of forces and displacements due to wind and earth tremors.

The vertical supports **9** are rendered effective to brace the building **1** and its interior framework against bending movement by horizontal struts **11** which are preferably provided opposite the transverse girders **6** at each of the floors of the building as shown in FIG. 5 of the drawings. The struts **11** are in the form of rectangular steel tubes, although other specific configurations may be employed if desired, and have their inner ends rigidly connected by steel plates **12** or other suitable anchorage to the columns **5** of the interior steel framework of the building. An encasement **13** of concrete or other suitable material is provided about the portions of the struts **11** extending outwardly from the wall **8** of the building to protect them against fire. The outer ends of the struts **11** are connected by spaced pairs of rollers **14** and **15** with the supports **9**. The struts **11** render the supports **9** effective to brace the building against lateral bending movement.

As shown in FIGS. 4 and 5, the vertical supports **9** can be fabricated by welding steel plates to form a housing the interior **16** of which may be filled with concrete or other material. The housing interior **16** is defined by spaced side plates **17**, an outer face plate **18**, a pair of spaced plates **19** extending toward each other from the inner ends **20** of the side plates **17**, and a T-shaped housing **21** that is welded to adjacent inner ends **22** of the plates **19**. The housing **21** defines a T-shaped opening **23** in which the outer ends **24** of the struts **11** and the pair of rollers **15** carried thereby are received. The rollers **15** may be readily assembled in the T-shaped slot **23** by holding the struts **11** in an intermediate position, with the axes of the struts generally horizontal but with the struts turned 90° from their final position. In such intermediate position, the axis of the rollers **15** extends vertically so that the rollers **15** may be inserted in the space **23** and then rotated 90° to a final position with the axis of the rollers **15** extending horizontally as shown in FIG. 4. When rotated to the position shown in FIG. 4, the rollers **15** engage with the surfaces **25** on the plates **26** of the housing **21** and the rollers **14** engage with the outer surfaces of the plates **19**, the surfaces **25** and the plates **19** thus operating as vertically-extending trackways which guide the vertical movement of the rollers **14** and **15** and thereby the movement of the struts **11** vertically along the supports **9**. In this manner, the supports **9** do not carry any part of the load of the building or its contents, and serve only to brace the building against bending movement by wind and other forces. This construction also provides for thermal expansion and contraction of the supports **9** relative to the building and its interior steel framework when they are subjected to different temperatures. In this respect, it will be apparent that vertical movement of the rollers **14** and **15** over the plates **19** and the surfaces **25** provide for unrestricted thermal expansion and contraction of the supports **9** relative to the rest of the building without inducing undesirable stresses and distortion.

The arrangement of connecting struts **11** in vertically spaced pairs opposite the ends of the girders **6** at each of the floors of the building, as shown in FIG. 5, represents the preferred practice of the invention. This arrangement, more particularly, results in the transfer to the exterior exposed columns **9** of lateral forces and bending moments at the exterior ends of the girders **6** at the points of their connections to the columns **5**. Two sets of rollers at a given floor level are necessary for transfer of bending moment at that particular floor level. It will be understood, however, that the bracing action of the exterior columns **9** may be accomplished by employing a single strut **11** opposite the girders **6** at each

of the floors or selected ones of such floors, and that such constructions are contemplated within the principles of this invention; such constructions of single struts transfer only lateral forces.

In FIG. 6 there is shown a modified strut, designated as a whole by **11***a*, for connecting the interior steelwork of the building with the exterior exposed columns **9**. In this showing, the pairs of rollers **14** and **15** are mounted on the end **24** of a square tube for assembly in the T-shaped opening **23** in the columns **9** as described above. At its inner end, the tube end **24** is carried by a connecting member **27** which has a V-shape that is formed by a pair of arms **28** secured at their inner ends to the plates **12**. From the plates **12**, the arms **28** converge toward and are connected to a vertical tie-bar **29** to which the tube **24** is secured.

A modified form of column **9** is shown in FIG. 7. In this showing, the column **9** comprises a pair of I beams **30** which are connected in spaced relation by a tie-plate **31** that is welded to flanges **32** along one side of the beams **30**. The beams **30** are connected in spaced relation so that the inner and outer surfaces **33** and **34** of the flanges **35** at the other side thereof form trackway surfaces for rolling engagement with the rollers **14** and **15** on the ends **24** of the struts **11** as described above, the struts **11** being connected with the columns **5** of the interior steelwork of the building as described above.

From the foregoing, it will be apparent that the columns **9** of this invention resist horizontal loadings, such as those produced by wind and earth tremors, and side sway caused by unbalanced vertical loading, the forces of which are transmitted to the columns **9** through the struts **11** and the rollers **14** and **15** mounted thereon. Attention is particularly directed to the fact that the columns **9** do not have to carry any portion of the weight of the building or that of its contents, which is supported solely by the columns **5** in the interior steelwork of the building. In this manner, the space occupied by the columns in the interior steelwork of the building is materially decreased, and a corresponding increase in the available floor space within the building is achieved.

As described above and as specifically shown in FIGS. 4 and 7, the external supports **9** are in the form of columns for bracing the interior steelwork of the building against side sway or lateral forces. However, it will be understood that vertical supports, fabricated in the form of trusses, may be used in place of the columns **9**. Specifically, columns **9** would very likely constitute one chord of a vertically oriented truss, or possibly one flange of a vertically oriented plate girder, said truss or girder resisting lateral forces and movements similar to the action of a "flying buttress."

While one embodiment of my invention has been shown and described, it will be apparent that adaptations and modifications may be made without departing from the scope of the appended claims.

I claim:

1. In a building construction, the combination with a building having an interior steel framework for supporting its weight and that of its contents, of bracing means for said building comprising a plurality of vertically-extending bracing members in positions spaced peripherally about and outwardly with respect to said building, and movable means connecting said bracing members with said framework for rendering said bracing members effective to brace said framework against lateral forces and displacement, said movable means providing relative vertical movement between said frame work and said bracing means, said bracing means being free of the said weight of said building and its contents.

2. A building construction as defined in claim **1** characterized by said connecting means comprising struts having connections at opposite ends thereof with said framework and said bracing members.

3. A building construction as defined in claim 1 characterized by a plurality of vertically-spaced spandrels connecting adjacent pairs of said bracing members, said spandrels and bracing members cooperating to provide a shell in the form of an exterior steel framework about said building.

4. A building construction comprising an interior steel framework including vertical columns for supporting the weight of a building and its contents, and an exterior steel framework for bracing said building against lateral forces and displacements, said exterior framework being in the form of a steel shell including vertically-extending supporting members spaced outwardly from and arranged at spaced intervals about said building, and movable means connecting said exterior framework with and rendering it effective to brace said interior framework against lateral forces and displacement, said movable means permitting relative vertical movement between said framework and said bracing means, whereby said exterior framework is free of the said weight of said building and its contents.

5. A building construction as defined in claim 4 characterized by said exterior steel framework including vertically-spaced spandrels securing adjacent pairs of said bracing members against lateral movement relative to each other.

6. In a building construction, the combination comprising a steel framework having vertical columns of sufficient size only to support the weight of a building and its contents, and bracing means for said framework comprising a plurality of vertically-extending bracing members in positions spaced peripherally about and outwardly with respect to said building, and a plurality of vertically-spaced struts connecting each of said bracing members with said framework for transmitting lateral forces from said framework to said bracing members, said struts respectively having connections at opposite ends thereof respectively with said framework and with one of said bracing members, at least one of said connections providing for relative vertical movement between said framework and said bracing members in response to unequal thermal expansion of said framework and said bracing members so that said bracing means is free of the said weight of said building and its contents.

7. A building construction as defined in claim 6 characterized by said framework comprising a plurality of horizontal girders at vertically-spaced intervals along the length of said columns, and by said struts being arranged in vertically-spaced pairs at selected ones of said horizontal girders in such a manner that differential axial forces in a pair of struts can result in the direct transfer of bending moment from one of said horizontal girders to the said exterior bracing members.

8. A building construction as defined in claim 6 characterized by the other of said connections being a rigid connection.

9. A building construction as defined in claim 6 characterized by said one connections comprising rollers supported on said struts and vertically-extending means providing a trackway in which said rollers have guided vertical movement.

10. A building construction as defined in claim 9 characterized by said vertically-extending trackway means being mounted on said bracing members.

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