May 29, 1934. S. BREINES 1,960,328

BUILDING STRUCTURE

Original Filed Dec. 23, 1930

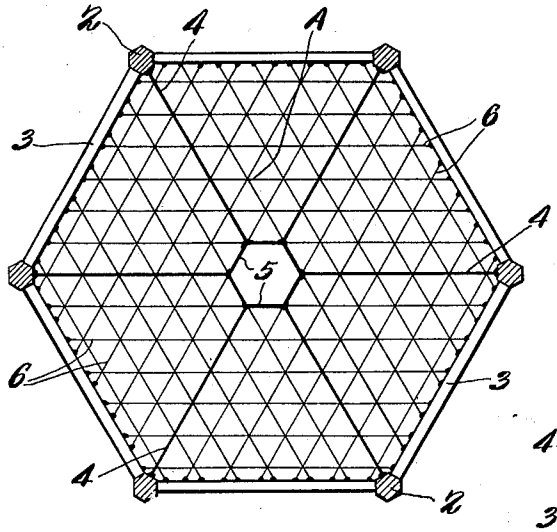
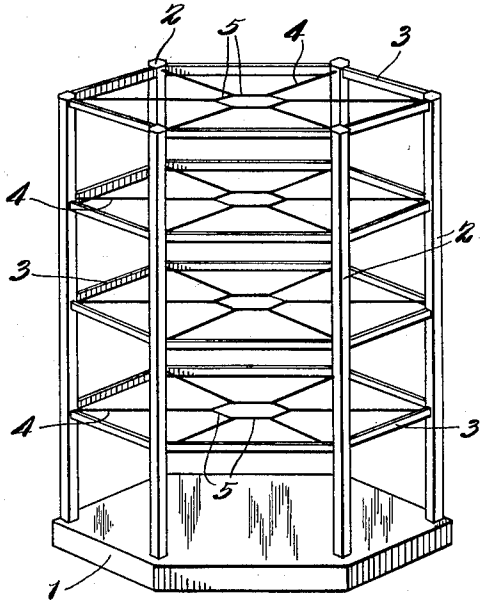


Fig 2

Fig 1



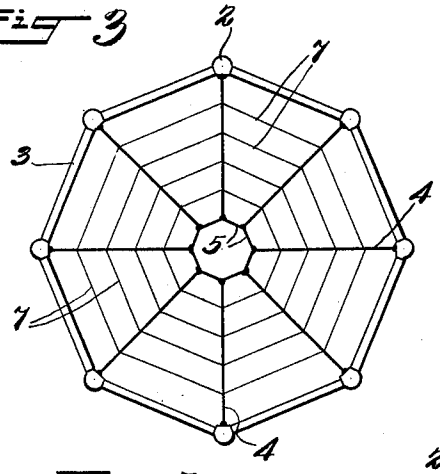


Fig 3

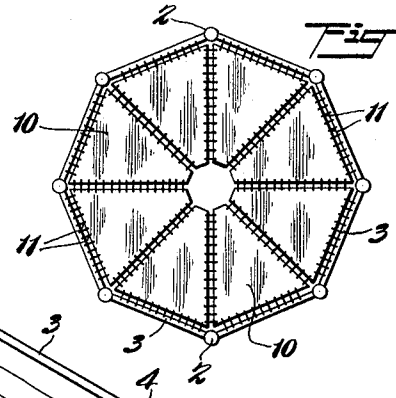


Fig 6

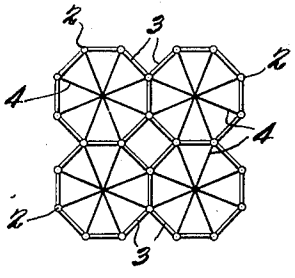


Fig 5

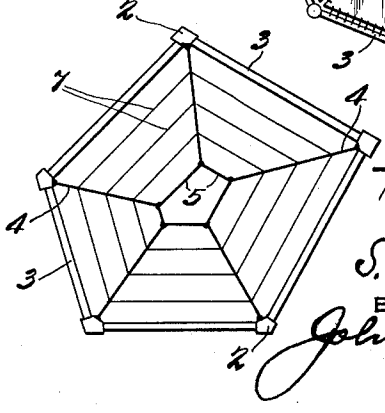


Fig 4

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BUILDING STRUCTURE

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4 Claims. (Cl. 189—1)

The invention relates to building structures and more particularly to novel and useful improvements in the design and construction of the supporting framework of buildings and other enclosures and weight-supporting structures.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the instrumentalities and combinations pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations and improvements herein shown and described.

The accompanying drawing, referred to herein and constituting a part hereof, illustrates one embodiment of the invention, and together with the description, serve to explain the principles of the invention.

Of the drawing:

Fig. 1 is a partly diagrammatic perspective view of a building framework embodying my invention;

Fig. 2 is a diagrammatic plan view of a floor frame of the building shown in Fig. 1;

Fig. 3 is a diagrammatic plan of a modified form of floor frame;

Fig. 4 is a similar view of a floor frame adapted to a building of irregular outline;

Fig. 5 is a diagrammatic plan showing a plurality of interconnected tension nets for covering relatively large areas; and

Fig. 6 shows a modified tension net utilizing metal sheets.

The invention is directed to providing an improved building structure or design by applying the strength and characteristics of building materials in the most efficient manner. My invention provides a building structure whereby the loads are supported substantially entirely by tension and compression stresses in the building framework, while bending stresses are largely eliminated.

In modern steel building frames of the conventional type, the building weight and floor loads are largely supported on rigid horizontal steel beams or trusses which carry the loads by the bending strength of these members. It is well known, however, that the strength of steel in compression and tension is many times greater than its bending modulus. By my invention, I provide a novel and highly efficient building structure or framework which utilizes, almost exclusively, the tensile and compressive strengths of the steel or other building material, and thereby avoids bending stresses as much as possible.

My invention is further directed to providing a building structure or framework wherein the weight-supporting stresses and reactions are segregated and distributed to members best adapted to withstand the character of stress transmitted thereto. That is, certain members of the building structure are designed to support weight substantially solely by tension, while other members of the structure are subjected almost entirely to compressive forces and reactions. This segregation and distribution of forces is exceedingly efficient and in accordance with recognized engineering practice as already employed in structures other than buildings, such as bridges, for example.

One present preferred embodiment of my invention comprises an application thereof to buildings such as office buildings, apartment houses, towers and the like. For inclosures of this type, I provide a substantially rigid external or peripheral frame composed of vertical columns and interconnecting non-vertical, peripherally disposed compression members. The interior of the inclosure is provided with horizontally disposed, weight-supporting media, comprising relatively flexible diaphragms stretched in tension across the interior of the peripheral frame and supported solely by said frame. Said weight supporting diaphragms preferably comprise substantially taut nets composed of interconnected filar members in tension between the peripheral frame members and adapted to transmit all non-peripheral loads to the frame by tensile forces.

The advantages inherent in the structure hereinbefore briefly described are numerous and very great. As already indicated, the structure of the invention is adapted to utilize the tensile and compressive strengths of steel to the best advantage. That is, loads carried on the tension diaphragm at the interior of the inclosure are supported by the flexible diaphragm and transmitted therealong by tensile reactions to the rigid frame. The vertical columns of the frame transmit the load to the foundation by compression reactions, while the non-vertical frame members between the columns are also in compression. Consequently the loading of the internal diaphragms tends to draw the peripheral frame more closely together, thereby tightening the whole structure, rendering it more homogeneous and unitary. Thus the greater the load on the floor diaphragms (within safe limits) the tighter and more compact the structure becomes. The tightening of

the frame provides effective internal bracing against wind and other external forces and also improves the insulation of the building by tending to close cracks and join the entire exterior surface.

The tension diaphragms operate to distribute localized floor loads to all parts of the weight-supporting frame. The net-like construction of the diaphragm causes the tensile reactions to travel along all members of the interconnected net, thereby distributing the load in a fluidlike manner to all parts of the peripheral frame and thence to the foundation. Thus all members of the diaphragm contribute to supporting a load at any locus on the net. This action is in contrast to that of a rigid floor beam in ordinary constructions, in that the beam and its contiguous frame members support the localized load almost solely by their own bending, shear and compression resistances, while the non-adjacent frame members and beams contribute little or nothing to the support of said localized load.

It will further be clear that, in a structure of the general type proposed, the stresses are segregated and distributed to the members best adapted to withstand them. For example, the floor diaphragms are composed substantially wholely of tension members of exceedingly high tensile strength, and the entire diaphragm is subjected substantially entirely to tension in supporting the floor loads. On the other hand, the rigid peripheral framework is almost entirely in compression under the supporting reactions from the attached tension diaphragms.

Another advantage which obviously accrues from my invention is that internal columns are disposed with, so that each floor space is entirely free and unobstructed from one peripheral wall to the other.

It will be understood that the foregoing general description and the following detailed description as well, are exemplary and explanatory of the invention but are not restrictive thereof.

Referring now in detail to present preferred embodiments of the invention, the accompanying drawings illustrate diagrammatically various proposed embodiments thereof. It will be understood, however, that these drawings are of a highly diagrammatic character, calculated chiefly to illustrate the underlying principles of my invention, and that the invention is not limited to any particular structure or building. On the contrary, my invention is capable of exceedingly wide and diverse applications in building work and may be adapted to buildings of types generally in use, as well as to buildings which may be developed from the general framework construction proposed herein.

Referring to the framework diagrammatically illustrated in Figs. 1 and 2, the buildings may rest on any suitable foundation such as the platform 1, at the periphery of which are erected vertical compression columns 2. For simplicity of illustration I have shown the building as hexagonal in outline, although it will be clear that the outline may be of other desirable or suitable shapes. The columns 2 are interconnected by non-vertical, rigid compression members 3, which are supported by the columns 2 and extend about the peripheral outlines of the framework.

The rigid peripheral framework shown in Fig. 1 may be provided with one or more substantially horizontal subdividing diaphragms, one of which is shown in greater detail in Fig. 2. These diaphragms may be utilized solely for uniting, strengthening and tightening the rigid peripheral frame, but preferably the diaphragms also serve as weight-supporting media and, in the embodiment shown, provide suitable floor frames at the different stories of the building. As embodied, the diaphragms may be formed of flexible filar members 4 of relatively high tensile strength. Said members 4 may be steel cables such as are used in bridge construction, for example, although as will be hereinafter described, the flexible diaphragm may be composed of different media possessing the suitable tensile strength and other characteristics required.

As shown, in Figs. 1 and 2, the flexible tension diaphragms may be essentially nets composed of radially extending cables 4 which are fast at their outer extremities to the columns 2. The inner or central extremities of the cables 4 are preferably united by relatively short tie cables 5, which join the ends of the radial members 4 and form a central open space in the net-work. As shown in Fig. 2, the diaphragm is preferably strengthened by the intermediate chords 6, comprising cables which are fast to the rigid horizontal frame members 3 and intersect to make up the body of the net. The chords 6 may be suitably interwoven and preferably welded or otherwise fixed at their points of intersection with each other and with the main radial cables 4.

In constructing a building in accordance with my invention, the peripheral frame comprising the rigid members 2 and 3 may be erected in any known or suitable manner. The building may then be tied together by incorporating the tensile diaphragms or net-works at the desired levels. Preferably, the net-works may be constructed as a whole or in suitable unit sub-divisions at a shop distant from the construction job, and only the work of fixing the net to the frame members need be done at the building. For example, hooks may be fixed to the cable ends for rapid attachment thereof to the frame members and/or other parts of the net. Turn buckles or other means may be provided in the tension nets for tightening same after they have been fixed to the frame. Thus, by virtue of my proposed methods of building erection, a great amount of present noise and hardship incident to the riveting work on steel building frames can be eliminated, while the actual amount of construction work on the job will be greatly reduced and made easier.

In constructing the tension net-work of my invention, I propose to use steel-wire cables, such as those commonly employed in bridge and other cable constructions. The tensile strength of such cables is commonly in the neighborhood of 200,000 pounds per square inch, which is many times higher than the strength of ordinary building steel in bending or flexure. This tremendous differential in strength of materials will permit elimination of any appreciable sag in the tension net, while maintaining same well within the tensile strength limits thereof under ordinary floor loads.

It will be clear, of course, that the tension diaphragms, such as the net-works shown herein, may be provided with suitable flooring frame and covering for supporting the actual floor surfaces. However, as already explained, the amount of sag on such a net-work will be very little and compares favorably with the sag in actual beam construction in modern buildings. Any such sag can be compensated for by building up the actual floor frame.

As already stated, it will be clear from Fig. 2 that every member of the tension diaphragm co-

operates in carrying the floor load. For example, a load localized at the point A is supported not only by the particular cables upon which it rests, but also, to a greater or less degree, by every other cable in the entire net-work. Each cable transmits its share of the load in tension to that part of the rigid frame to which it is connected, and the frame is thereby put in compression. The tension members 4 drawing on the vertical columns 2, transmit the floor load through said columns to the foundation. At the same time, the load tends to tighten the entire net and draw the columns toward each other, thereby horizontally compressing the rigid cross-members 3 of the rigid frame. Consequently the entire load of the building is fluidly transmitted to the rigid framework, and at the same time the whole structure is tightened and unified by the internal tension in the diaphragms. The tighter the diaphragms are drawn (within safe limits) the more rigid and compact the entire structure becomes. Furthermore, due to the fluid-like transmission of loads throughout the diaphragms, every member of the structure contributes to support every load on said diaphragm.

In the form of net illustrated in Fig. 2, there may be a certain amount of flexure or bending force exerted on the cross-members 3, due to the pull of intermediate cables 6. However, this bending is not serious and, if desired, may be partially compensated for by introducing a compensating bending set in the opposite sense to the members 3 when or before the frame is erected.

Referring now to Fig. 3, a modified form of tension net or diaphragm is shown, wherein the radial cables 4 are strengthened and interconnected by concentric supporting cables 7, which extend substantially parallel to their corresponding peripheral frame members 3. In the form shown in Fig. 3, the entire load of the net is transmitted solely to the vertical columns 2 by the radial members 4 and there is thus no bending stress thrown upon the peripheral members 3 by the tension net. As shown in Fig. 3, the outline of the building to which this net is adapted may be octagonal, and it will be understood that this general form of net may be similarly adapted to buildings of different polygonal outlines.

The basic features of my invention may be likewise adapted to buildings of irregular outline. As shown in Fig. 4, for example, a tension net of the general design of that shown in Fig. 3 is shown adapted to a pentagonal building of non-uniform outline.

It will be noted that the tension nets shown are preferably arranged to leave a central clearing within the tie members 5. This clearing may conveniently form space for centrally-disposed elevator shafts, stairwells, light and air shafts, or like equipment for the building. The central location of these superposed clear spaces is well adapted for such uses and is in accord with recognized building practice, it being evident that the most efficient location for elevators and similar facilitites is at the center of a building.

While I have hereinbefore described and shown single tension nets for building construction, it will be understood that the invention is not limited thereto. In covering large areas, for example, I propose to provide a plurality of interconnected tension nets of relatively small unit size. A suggested form of such construction is shown in Fig. 5, indicating a plurality of polygonal tension diaphragms suitably interconnected and peripherally supported according to the principles hereinbefore described. The number of nets which could be so united is substantially unlimited, it being understood that when necessary or desirable, suitable rigid frame members may be supplied internally of said combined nets as well as at the periphery of the inclosure.

The invention is not limited to the use of flexible filar members for forming the tensile diaphragms. In certain constructions, the diaphragms may be formed of rigid or substantially rigid members, although it will be understood that said diaphragm members will be subjected solely or substantially solely to tension forces, in accordance with the principles hereinbefore set forth.

As one modification of my invention, utilizing non-filar means for forming the tension diaphragms, I propose to use relatively thin metal sheets. As is well known, steel sheets possess great tensile strength in all directions and for such reason are admirably adapted for the purposes of my invention. Referring to Fig. 6, the tension diaphragm is composed of a plurality of substantially triangular sheet-metal forms 10, which are freely connected in tension and act as a net. The connecting members 11 may be flexible cables or the like.

It will be clear from the foregoing description, taken in connection with the accompanying drawing, that buildings constructed in accordance with my invention may be totally or substantially free from internal supporting columns and framework. All the load of the building is transmitted to the foundation through the peripheral framework and the floor areas are thus unencumbered. While I have hereinbefore described and shown my invention as embodied in building structures and principally in its weight-supporting applications, the principles of the invention may also be applied to other types of structures. For example, the invention may be utilized in high towers, tanks and similar cylindrical structures, where the tension diaphragms will serve principally as internal bracing and tightening members rather than essentially as floor frames or weight supporting means.

The invention in its broader aspects is not limited to the specific mechanisms shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What I claim is:—

1. In a building structure, in combination a substantially horizontal, weight-supporting medium comprising a rigid peripheral frame and a relatively flexible diaphragm stretched across the space within the frame and peripherally supported thereby, said diaphragm being in tension with respect to the frame and adapted to support interiorly disposed loads by tensile transmission thereof along the diaphragm to the compression frame.

2. In a building structure, in combination a substantially horizontal, weight-supporting medium comprising a rigid peripheral frame and a relatively flexible diaphragm stretched across the space within the frame and peripherally supported thereby, said diaphragm being in tension with respect to the frame and adapted to support

interiorly disposed loads by tensile transmission thereof along the diaphragm to the compression frame, and rigid columns connected to said framework solely at the periphery thereof for transmitting the entire load to the foundation.

3. A building structure including in combination a rigid peripheral frame, and means for supporting floor loads and transmitting the weight thereof to the frame substantially solely by tensile reactions comprising a substantially flexible network comprising metal sheets in tension flexibly fixed to the rigid frame.

4. A building structure including in combination a rigid peripheral frame, and means for supporting floor loads and transmitting the weight thereof to the frame substantially solely by tensile reactions comprising a substantially flexible network comprising interconnected cables and metal sheets fixed to the rigid frame.

SIMON BREINES.