Aug. 10, 1943. M. SASSO 2,326,688

STRUCTURAL ELEMENTS

Filed Jan. 31, 1941 2 Sheets-Sheet 1

Fig. 1.

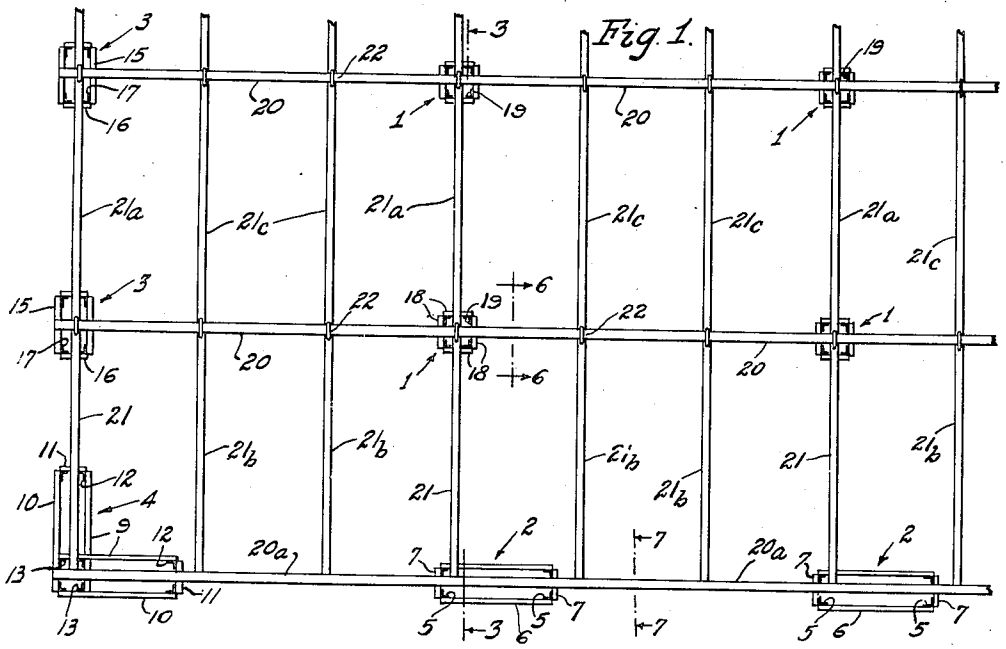
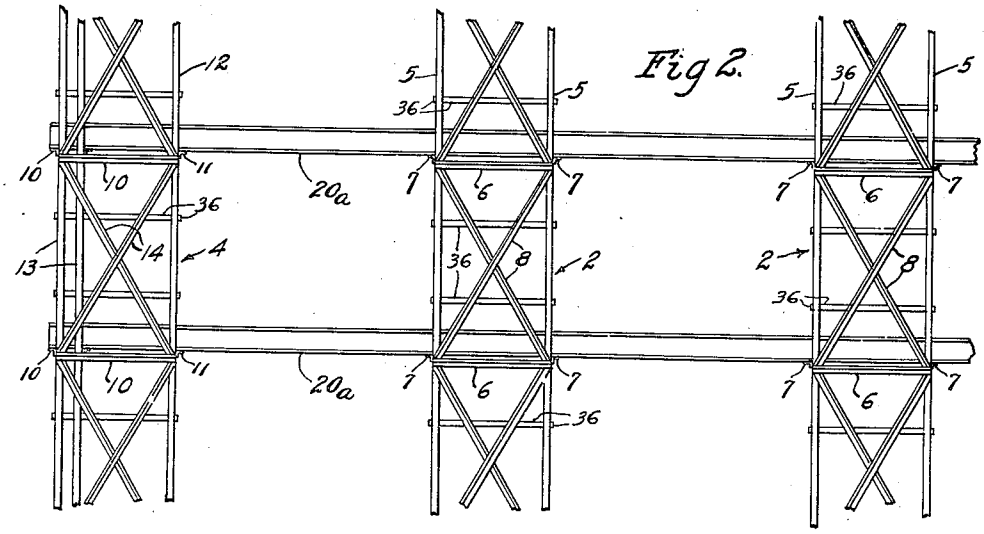


Fig 2.



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Fig. 3.

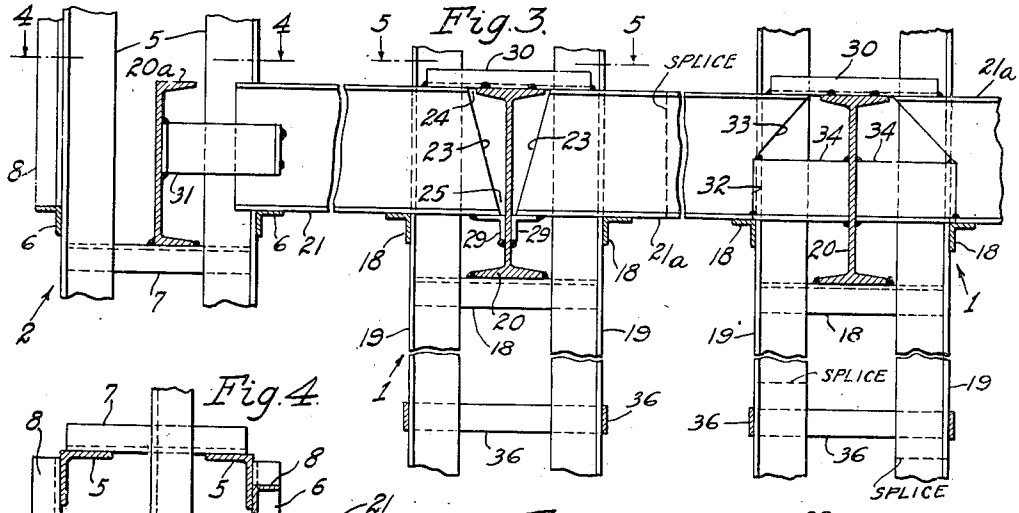


Fig. 4.

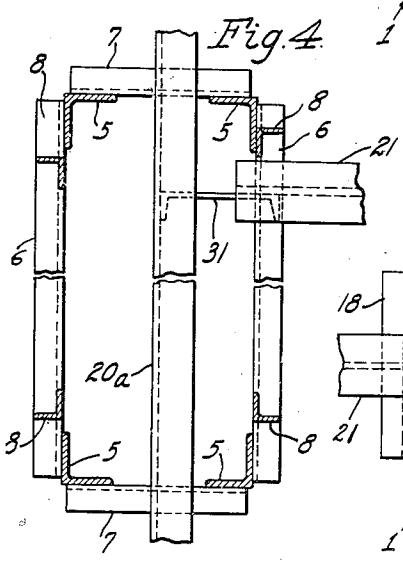


Fig. 5.

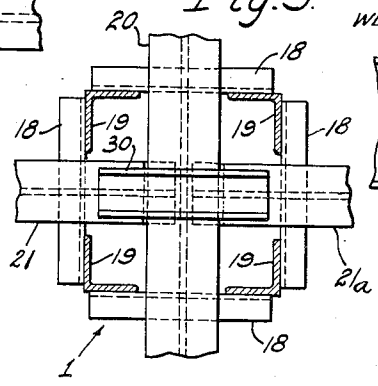


Fig. 6.

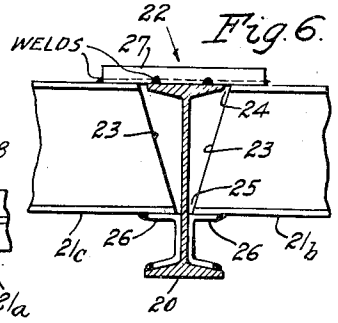
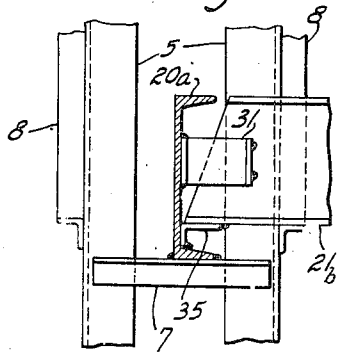


Fig. 7.



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UNITED STATES PATENT OFFICE

2,326,688

STRUCTURAL ELEMENTS

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Application January 31, 1941, Serial No. 376,879

4 Claims. (Cl. 189—34)

This invention relates to a means and method for installing and erecting metallic or other members which are designed and configurated for carrying variable loads in a building structure, especially a building having a plurality of floors. The invention principally involves column, girder and beam elements, and means for relating them to each other in such a manner to form a building capable of withstanding greater vertical and horizontal loads than present steel framed buildings, without increasing the dead weight of the structural elements involved.

At present, in the usual building construction work the columns and girders are generally joined by a connection in the web of the girder for transferring its reaction to the column. This method of construction limits the length of the girder and beam to the clear distance between columns face and makes these beams and girders structurally discontinuous members. In some cases however a special connection in the top and bottom flanges of the girder is made for transferring a fraction of the moment from girder into column. This type of connection is never 100 percent efficient; structurally it is neither truly rigid nor truly continuous. In the present type of construction, the columns are subjected not only to large bearing loads, but also to large varying lateral loads caused by wind and earth shocks. The live loads unsymmetrically disposed upon the various floors of the building, augmented by horizontal loads induce large moments in columns rigidly connected to girders and beams. The stresses due to these loads are apt to rise to such serious proportions as to fracture the connecting columns where such an uneven load is the greatest.

In the present invention, the structural layout is designed to avoid the above pointed out faults, because the girders are continuous across their supporting columns and may span more than two columns, the length of the girder is limited only by convenience of handling during erection; where a splice of girder to girder is necessary, this is made at the calculated point of zero shear lying somewhere between columns. These girders are continuous across their supports but unrestrained by the supporting columns, thus permitting the distribution of moments and shears to adjacent spans without introducing moment and shear into the column. The lateral floor loads are transferred mostly to the peripheral walls and columns along the sides of the structure so that the stresses can be absorbed where solid wall conditions or proper bracing is provided for.

The columns in the present invention are preferably designed according to the open crate or lattice work type of construction in which the radius of gyration is much greater than in the solid type of columns made of H-sections, I-sections and the like, and therefore capable of carrying larger combined loads. By this invention all horizontal framing for each floor is structurally rigidly joined together, but such framing is preferably not rigidly joined to the column unless so required by local building ordinance. The framing rests or bears upon horizontal cross members of the columns and is attached to the column by the bottom flange only. The column members are well removed from the center of gravity of the columns so as to have relatively large radii of gyration. Therefore, by this construction, lateral thrusts upon the building structure, due to wind and earth shocks, are mostly transferred to the outer walls of the building rather than to the columns of the building. This avoids high flextural stresses in interior columns and presents a structure having a higher factor of safety and therefore much more stable than a similar structure having the usual column designs and joints. The walls and columns parallel to a lateral force are the ones which absorb the major portion of the force.

By this invention the practice of steel construction may be changed to a simpler, speedier and more economical one. By substituting welding to riveting or bolting the shop fabrication can be omitted entirely. The very type of design evolved in this invention permits to use column members of any length, thus eliminating the necessity of cutting the exact length, milling of the ends, drilling, splice plating and shop riveting as usually done, the girders may span more than two supports and need not be cut to exact length, drilled or punched etc., this applies to all members of a building structural frame.

An object of this invention is the design of reticulated columns for buildings arranged to receive their respective full share of the vertical loads, but a relatively small proportion of the lateral loads.

Another object of this invention is to substantially reduce the weight of the structural members (columns, girders, beams, etc.), designed to carry the same load as those employed in the present system thereby economizing on the cost of material and enabling the same amount of labor to construct a larger building, and to reduce the length of time required to complete the struc-

tural frame of a building, therefore permitting earlier occupancy of the building.

This application is a continuation, in part, of my former application Serial No. 211,826, filed in the United States Patent Office June 4, 1938.

Other objects, advantages and features of invention will hereinafter appear.

Fig. 1 is a partial plan view of one of the floors of a building.

Fig. 2 is a partial elevational view of the same building.

Fig. 3 is a sectional view taken on an enlarged scale on the plane indicated by line 3—3 on Fig. 1.

Fig. 4 is a sectional detail taken on the plane indicated by line 4—4 on Fig. 3.

Fig. 5 is a sectional detail taken on the plane indicated by line 5—5 on Fig. 3.

Fig. 6 is a sectional detail taken on the plane indicated by line 6—6 on Fig. 1.

Fig. 7 is a sectional detail taken on the plane indicated by line 7—7 on Fig. 1.

The drawings illustrate a preferred form of the invention and teach how to make, use and vend the same, but it is to be understood that the drawings and description thereof are not to limit the invention in any sense whatsoever, except as limited by the appended claims.

The numeral 1 represents similarly constructed vertical columns in a building structure which are substantially square in horizontal section, and in which the radii of gyration of each column are substantially equal in all directions from the center thereof. Outer columns 2 and 3 are oblong in horizontal section and have their greatest radius of gyration parallel with their respective sides of the building. The corners of the building are preferably provided with angularly constructed columns 4, the legs thereof being interlaced together as shown for purposes of greatest strength and stability.

The columns 2 are made up of four spaced apart corner angle irons 5 which run from the foundation of the building to the height thereof. These angle irons may be made of a plurality of lengths welded or otherwise securely fixed end to end. Each of these columns are provided with horizontal struts or bars 6 and 7 which, by preference and as shown are sharp angle irons securely welded, riveted or otherwise fixed to the vertical corner members 5. Between the horizontal struts are placed the diagonal stress members or stiffeners 8 which are also sharp angle irons and which are securely fixed to the elements 5, 6 and 7. Between the horizontal struts are also placed horizontal yokes 36, spaced vertically as best suited, as shown, to completely form a stable column.

The corner column 4 is constructed of inner and outer horizontal struts 9 and 10 respectively, and shorter struts 11, all of which are rigidly joined to vertical angle irons 12. The inner struts 9 cross, as shown, have their outer ends fixed to other vertical angle irons 13. Diagonal stress members or stiffeners 14 are provided, as shown, to complete the column.

The columns 3 are very similar to the columns 2 and comprise the horizontal angles 15 and 16 rigidly fixed to the vertical angles 17. These columns are also provided with diagonal stress members (not shown) similar to 14 and 8 of the other columns and horizontal yokes 36. The columns 1 are also constructed in a manner similar to the columns 2 and 3 except that they are substantially square in horizontal section. These columns 1 comprise horizontal struts 18 on all sides which are rigidly fixed in any suitable manner to the vertically spaced apart angles 19. Diagonal stress members or stiffeners (not shown) but similar to 8 and 14 in columns 2 and 4 respectively. Also horizontal yokes 36 as shown in Figure 3 are employed to complete a well designed column.

The floor framing consists principally of girder sections 20 and 20*a* and cross beams 21, 21*a*, as shown in Figs. 1 and 3 of the drawings. The girders 20 are structural steel I-members, whereas the girders 20*a* and beam 21 are preferably structural steel channel members. The girders and beams are spaced in accordance with good practice to carry and distribute the various floor loads for which they are designed. The girders and beams 21*b* and 21*c* are rigidly joined together at the points indicated by 22 in Fig. 1 and better shown in Fig. 6.

The I-beams 21*b* and 21*c* (Fig. 6) have their juxtaposed ends cut on a bias indicated by 23 and are positioned so that their top flanges are slightly spaced from the top flange of the girder, as indicated at 24, the lower flanges of the beam being slightly spaced from the web of the girder 20 as indicated by 25. This spacing allows for erection and connection of these members. The bottom flanges of the beams 21*b* and 21*c* rest upon the top edges of the angular plates 26, each plate 26 being welded or otherwise securely fixed to the bottom flanges of the beams, also to the lower portion of the girder web, and to the flange of the girder. In order to securely tie the ends of the beams together, a tie plate consisting of a channel 27 is provided having its web securely welded or otherwise fixed to the top flanges of the beams 21*b* and 21*c* as well as the top flange of the girder 20.

The details of columns 1 are best shown in Figs. 3 and 5 and will now be described. This column is made up of upright angles 19 spaced as shown to by-pass the beams and girders, to which the horizontal peripheral struts 18 are rigidly fixed, these struts being at the proper elevation to receive the bottom flanges of the beams and girders which join in the center of the column. The girder 20 may be of a different depth than beam 21, the former being shown in the drawings as deeper than the latter, therefore the struts which act as bearing members of the girders may be spaced at different level than the struts acting as bearing members of the beams. In Fig. 3 the girders 20 are shown welded to the lower pair of opposite struts 18. The beams 21 and 21*a* are biased as shown at 28 and are spaced as shown in Fig. 6. These beams rest upon and are attached by welding or otherwise to sharp angles 29 which are rigidly fixed, preferably by welding or otherwise, to the lower part of the web 20. Like the joint shown in Fig. 6, a bar 30 is fully connected to the top flanges of the beams and also to the top flange of the girder by welding or otherwise, thus rigidly securing them together. The bottom flanges of the beams 21 and 21*a* are connected, as by welding or otherwise to the bearing angles 12, which in turn are rigidly connected to the column legs 19, and abut the web of the girder to which they are rigidly connected. This type of joint, in which the top and bottom flanges are developed 100 percent and the shear carried (Fig. 3) by independent strut members 18 or else by strut members 18 and 29, is structurally fully continuous

and therefore capable of transmitting the full amount of stresses from one member into the other. To attain the maximum load carrying capacity of the column its vertical legs are made to work as short columns by means of continuous batten plates 36 fully circumscribing the column in the form of a closed tight loop or yoke rigidly fixed to the column legs preferably by welding or otherwise at such a vertical distance that the ratio of slenderness of the leg member between battens does not exceed 60.

The columns 2 (best shown in Figs. 3 and 4) comprise the uprights 5, to which long struts 6 and short struts 7 are rigidly fixed preferably by welding or otherwise. The wall girder 20*a*, in the form of a channel iron, or any other structural shape best fitted for the purpose, rests upon and is rigidly attached by welding or otherwise to the short struts 7 whereas the beams 21 rest upon the long struts 6, the girder 20*a* and the beam 21 being attached in such a manner to their respective supports that they are free to rock on them. The beam is tied to the girder, however, by a section of channel indicated by 31 which is welded or otherwise secured to the web of the channel and the web of the I-beam as shown. When the beam 21 is being placed into its position in the framing (Fig. 3), the end toward the column 2 is first swung into place because of the large clearance provided between the channel web and the end of the beam to be placed thereat. The other end of the beam 21 is then swung into place so as to rest upon the angle 29 of the girder 20. This operation, is not feasible for installing the beam 21*a* and can not be practiced, because of the construction of the columns 1 between which said beam extends, in that there is not sufficient clearance between said columns to permit such a method of installation. Each beam 21*a*, therefore, has one end biased, as shown at 23 in Fig. 3, but the other end has an offset cut 32 and a short biased cut 33. To install the beam 21*a*, the end 23 is first swung into place to rest upon the angle 29, and then the end 32—33 is lifted and set into place upon the support 18. In order to close the gap between the end 32 and web of girder 20 and to rigidly fix the beam to the girder 20, plates 34 are placed thereat as shown. These plates are welded or riveted to the cut end 32 of the beam and also to the web of the girders.

From the foregoing, it is apparent that the entire floor framing is equal to an integral piece. Since the floor framing is not fixed to the vertical members of the columns, it does not set up such inflexible stresses in the columns as would result if it were directly secured to their vertical members.

This invention is essentially an improvement on the art of design and construction, and not only makes the structure absolutely saft (structurally) but economical and speedy of erection as well.

The continuity of girders in accordance with this invention is attained by eliminating the usual kind of connection of the girder to the column by by-passing the girder through the column. The girder member is not interrupted at its supporting columns, it is continuous from one column to another and may span any number of columns, the limiting length of the girder is the practicability of handling it in transportation and erection. In many instances, a single girder may be used throughout an entire row of columns; when more than one length is required a moment splice preferably located at point of zero shear in girder (not shown), will make such girder continuous throughout the length of the structure.

The columns bearing all vertical loads are each made up of four or more leg members, preferably angle iron sections, or special sections suitable for the conditions, made continuous preferably by butt welding (not shown) or otherwise, the splice being made at any point desired. The vertical corner members thereof are spread apart a distance not less than that required to pass the girders and beams through, with desired clearances.

The floor of a building constructed according to this invention is a rigid continuous diaphragm because the beams and girders as set forth are truly continuous and the columns nearly free of induced bending. The horizontal loads through this diaphragm (floor) can be directed to resisting elements such as interior walls, exterior pilaster and walls, etc., designed to resist horizontal loads in addition to vertical loads. This facilitates computations in that it will not require moment distribution between interior columns and beams due to vertically and horizontally combined loads. All this results into a more definite, and consequently a more correct determination of stresses.

From Figs. 3 and 6 it will be seen that the girder sections 20*a* (which are channel shaped in cross section) and the girder sections 20 (I-shaped in cross section) all have their webs extending vertically as to their widths. These sections 20*a* and 20 form a part of the connection between the horizontal floor members and the columns; and, owing to the fact that the greater part of the vertical extent of each of their webs is in an unattached relation to the surrounding structure, said sections are of a slightly yielding character. In the I-beam web shown in the central portion of Fig. 3, about two-thirds of the breadth of the web is in an unattached relation to the surrounding structure, and in the corresponding webs shown in the right hand portion of this view, and in its left hand portion, in each case web portions of considerable vertical extent are free from welds or other attaching means. These unattached web sections permit a minute yielding under heavy stresses, which conserves the whole structure when subjected to severe shocks.

The columns 2, 3 and 4 along the outer walls of the building have their greatest cross-sectional spread parallel with their respective adjacent walls; this gives these columns a large moment of inertia, and since the horizontal force resisted by a column is directly proportional to its moment of inertia in the direction of the force, the side wall columns along with the usual fill-in structure become capable of resisting the horizontal forces with a larger factor of safety.

I claim:

1. In a metallic frame building having a plurality of inside and outside columns supporting one or more horizontal fabricated rigid frames, said columns having large air cores and borders of horizontal members fixed to the columns, said frames comprising a plurality of beams rigidly joined together in the air cores of the columns, said beams having subjacent support upon said members, the outside columns being oblong in horizontal section and having their greatest width parallel to the outside walls of the building.

2. In a building structure having air core columns which have vertical corner legs and horizontal floor members; horizontal supports fixed to the legs and forming a perimetrical part of

their respective columns, said members passing through the columns and being continuous between them and resting upon the supports at positions spaced from the legs of the columns, said members having rigid connection with one another and non-rigid connection with the columns whereby said members may rock with respect to the columns.

3. In a building structure having polygonal columns with continuous vertical legs and continuous horizontal floor members, horizontal supports secured externally to adjacent legs of said columns and forming a part of their respective columns and materially spaced from the center of gyration thereof, said members resting upon the supports and spaced internally from the legs of the columns, said members having connections with one another and connections with independent columns, said continuous members being rigidly spliced intermittently throughout their respective lengths.

4. In a building structure, an open columnar structure rectangularly shaped in cross section having a vertical leg in each corner and struts secured to its sides, a horizontal floor girder of multi-span length extending integrally across the center of the column in a spaced relation to said legs and resting upon a pair of said struts, a divided floor beam extending across said column in a spaced relation to the legs thereof and supported upon another pair of said struts with end portions adjacent to said girder, said girder and beam both having floor-supporting portions exterior to said column.

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