July 12, 1927. 1,635,231

W. S. ST. JOHN

BUILDING CONSTRUCTION

Filed Nov. 2, 1922

Fig. 1

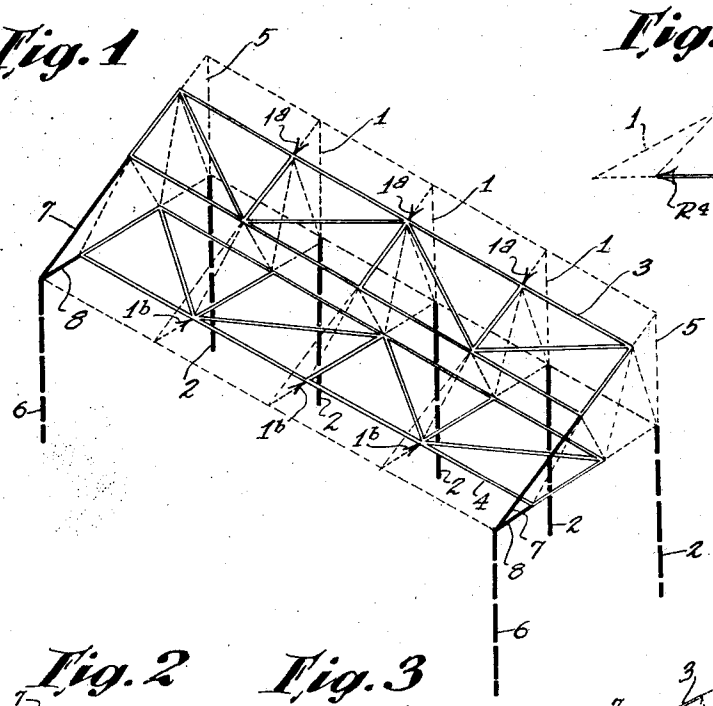


Fig. 6

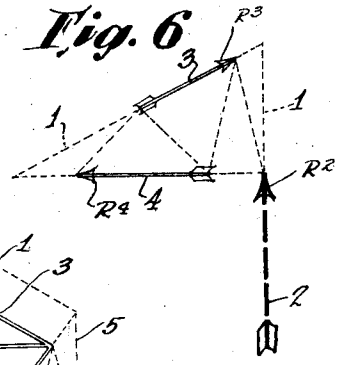


Fig. 2

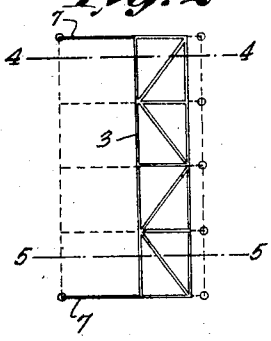


Fig. 3

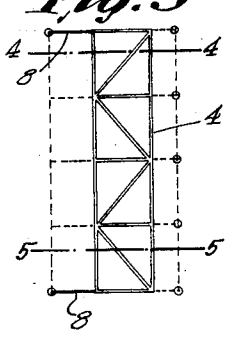


Fig. 4

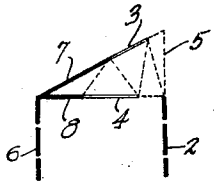


Fig. 5

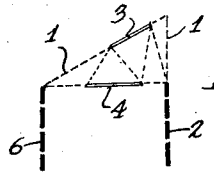


Fig. 7

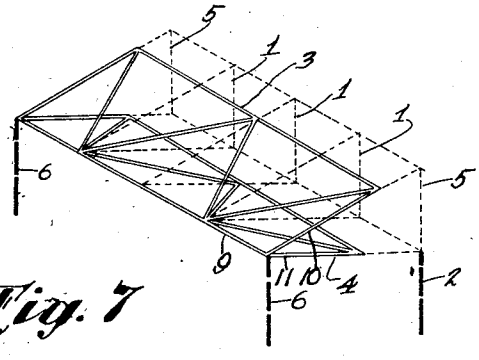
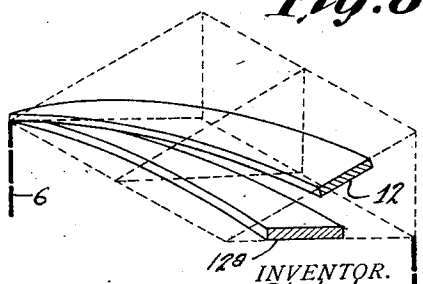


Fig. 8



INVENTOR.
Walter S St. John
BY Jas. H. Griffin
ATTORNEYS.

Patented July 12, 1927. 1,635,231

UNITED STATES PATENT OFFICE.

WALTER S. ST. JOHN, OF NEW YORK, N. Y.

BUILDING CONSTRUCTION.

Application filed November 2, 1922. Serial No. 598,616.

This invention relates to structural framing, and has for its general object the provision of a simple and efficient construction for supporting trusses or beams in a theatre balcony or similar structure where it is desirable that the number of columns used at the forward end of the framing be reduced to a minimum.

Modern practice in theatre designs forbids the use of columns to support the portion of the balcony that overhangs the chairs on the orchestra floor, since such columns would obstruct the view of the stage from the chairs back of them. The balcony floor usually rests on the top chords of balcony trusses, which trusses lie parallel to the longitudinal axis of the theatre, and cantilever forward (toward the stage) from a transverse fulcrum truss, upon which the balcony trusses pivot. The fulcrum truss, being over the orchestra floor chairs, cannot be supported upon columns unless it extends the entire width of the theatre (between columns at the side aisles). Except when the theatre is of small size, a fulcrum truss cannot be built, within the space available, strong enough to span the full width of the building. It then becomes necessary to support the fulcrum truss at each end by a huge cantilever supporting truss which extends diagonally, to the end of the fulcrum truss, from an anchorage near the corner of the back and side walls of the building; and pivots upon an equally hugh fulcrum supporting truss extending diagonally from a column back of the orchestra floor chairs, to a column at the side aisle.

Thus the load of a balcony truss is carried successively, before reaching a column, by five other trusses, three of which are fulcrum trusses which have to sustain an additional balancing load at least equal to the cantilever load. Often the weight of the fixed portion of the balcony is insufficient to balance the weight of the cantilever portion, and the resulting uplift at the supports has to be balanced by anchorage to other parts of the building, or often by increasing the size of footings for the sole purpose of providing weight; further, the entire amount of the uplift is added as load to the already overburdened balcony framing. The presence of trusses located diagonally in plan prevents the use of the space below the balcony floor in connection with the mezzanine floor, which typically occurs at this level. The connections of the heavy diagonal members are among the most difficult known to steel fabrication, and typically require field riveting.

In accordance with the present invention, in contradistinction, I employ only two supporting trusses; there are no fulcrum trusses or trusses located diagonally in plan; there is no framing in the space below the balcony floor except the balcony trusses, which can be readily enclosed in partitions; and there can be no uplift under any conditions of loading.

Features of the invention, other than those specified, will be apparent from the hereinafter detailed description and claims, when read in conjunction with the accompanying drawings.

The accompanying drawings illustrate, diagrammatically, balcony construction showing a typical mode in which I contemplate applying the principle of this invention, but the constructions therein shown are to be understood as illustrative, only, and not as defining the limits of the invention.

Figure 1 is an isometric view of balcony framing embodying the present invention.

Figure 2 is a plan view at the top chords of the balcony trusses.

Figure 3 is a plan view at the bottom chords of the balcony trusses.

Figure 4 is a section on the line 4—4 of Figures 2 and 3.

Figure 5 is a section on the line 5—5 of Figures 2 and 3.

Figure 6 is a reaction diagram of an intermediate balcony truss as it functions in the construction of Figure 1; and,

Figures 7 and 8 are isometric fragmental views illustrating diagrammatically modified forms of the invention.

In the accompanying drawings, there is illustrated an application of the invention, in an elementary form, to the framing of a theatre balcony. It is to be understood that trusses of other forms, or beams or girders, may be used instead of the trusses shown. Floor and ceiling beams, and other parts of the balcony framing have been omitted from the drawings for simplicity. Balcony trusses and bracing are indicated by relatively fine dotted lines, columns by relatively heavy dotted lines, supporting trusses by double, solid lines, and supporting truss connecting members by heavy solid lines. In the case illustrated, certain members of bal-

cony trusses act also as members of supporting trusses or as supporting truss connecting members, and such members are shown by the indication of the latter parts.

In the drawings, the balcony is shown as supported from beneath on columns 2 and 6. The columns 2 are in a row beneath the rear end of the balcony and may, if desired, be in the form of a wall extending transversely beneath the balcony. The columns 6, two in number, are arranged at the extreme opposite ends of the balcony, so as to underlie and support the front of the balcony at these points. The balcony is formed from a plurality of intermediate trusses 1, hereinafter termed intermediate balcony trusses, and end trusses 5 hereinafter termed end balcony trusses. All of these trusses are shown in dotted lines in the drawings. The rear end of each of these trusses rests upon and is supported by one of the columns 2 or on the continuous wall which may be used in lieu of the columns. The trusses 1 and 5 rest upon the supports 2 and 6 and in practice are preferably secured thereto in such a manner as to preclude their shifting on the supports. No bending is transmitted at any connection of the structure although hinge or roller connections may be utilized between the trusses and supports if desired. The forward end of each end truss 5 is directly supported on one of the columns 6 which, in practice, are located on either side of the orchestra chairs. It may be here noted that the use of columns in these positions is typical of modern balcony support.

In applying the present invention to the construction as thus far described, I utilize two distinct supporting trusses which are respectively designated 3 and 4 in the drawings, and are shown in double solid lines, so that their presence may be readily determined. I term truss 3 the top supporting truss and position this truss in the plane of the top chords of the balcony trusses 1 and 5, as clearly shown in Figure 1. The truss 4, I term the bottom supporting truss and locate this truss in the plane of the bottom chords of the balcony trusses 1 and 5. The trusses 3 and 4 are connected to all the intermediate trusses.

In order that both of these trusses 3 and 4 may be properly supported, I further utilize connecting members 7 whose axes lie in the plane of the top supporting truss 3, and are parallel to the planes of the balcony trusses. These members connect the opposite ends of the top supporting truss 3 to the upper ends of the columns 6, and I similarly connect the ends of the bottom supporting truss to the columns 6 by like connecting members 8, whose axes lie in the plane of the bottom supporting truss, and are parallel to the planes of the balcony trusses. As shown in Figure 1, the connecting members 7 and 8 at each end are located so as to intersect where connected to the juxtaposed column 6, and are connected to each other at such column. The connecting members 7 and 8 may form a part of the end balcony trusses 5, and are so shown in Figure 1, but if they do, such parts of the end trusses are sufficiently strengthened or reinforced to enable such parts to carry the exterior load imposed thereon by the supporting trusses 3 and 4.

When this construction is employed, it will be apparent that the top supporting truss 3 receives from each intermediate balcony truss 1 the load indicated by the arrows 1^A in Figure 1, while the bottom supporting trusses 4 will receive loads from the intermediate trusses indicated by the arrows 1^B in Figure 1.

Figure 6 graphically illustrates the condition of equilibrium of an intermediate balcony truss when supported in the manner described. A vertical reaction R 2 is provided by the column 2; a reaction R 3, acting along the axis of the top chord of the balcony truss, is provided by the top supporting truss 3; and a reaction R 4, acting along the axis of the bottom chord of the balcony truss is provided by the bottom supporting truss 4. The directions and points of application of the three reactions being thus fixed, their intensities may be ascertained from the three fundamental equations of statics; to wit:

Summation H=O 1
Summation V=O 2
Summation M=O 3

The solution of these equations for any given loading upon the intermediate balcony trusses will determine the loads for which the supporting trusses must be designed. For any loading upon the intermediate balcony trusses, it must always be true from equation 1 alone that the horizontal component of the reaction R 3 is equal and opposite to the reaction R 4 since the remaining forces acting upon the balcony truss (the reaction R 2 and the loads) are vertical and have no horizontal components.

Considering now the structure as a whole, it becomes apparent that, since the horizontal components of the loads upon the top supporting truss 3 are equal and opposite to the loads on the bottom supporting truss 4, it follows that the horizontal component of the load on the top connecting members 7 must be equal and opposite to the load upon the intersecting bottom connecting members 8. Therefore, the columns at which the members 7 and 8 meet, receive as a load only the vertical component of the load upon the top connecting members 7 since the horizontal component is neutralized by the load upon the bottom connecting member 8.

In the showing of Figures 1 to 6 of the drawings, the top and bottom trusses 3 and 4 are shown as positioned intermediate the front and back edges of the balcony and it is for this reason that the connecting members 7 and 8 are employed. In the construction of Figure 7, however, I have shown the trusses 3 and 4 as of sufficient depth to extend to a line of intersection on the front edge of the balcony so that a single member 9 serves as a common chord for both of these trusses. In this case, the connecting members 7 and 8 will of course be omitted, since the web members 10 and 11 of the supporting trusses supplant them. The depths of the supporting trusses may then be so adjusted that the stress in the member 9, when acting as a chord of the upper truss 3, is opposite to this stress as a chord of the lower truss 4, so that the resultant stress will be zero and the member 9 will function merely as a bracing. In other forms of the invention, the chord members of the supporting trusses 3 and 4 may also act as chord members of trusses in vertical planes, which latter trusses may or may not be a part of the balcony truss framing.

It is apparent that the supporting trusses of this invention consitute the most efficient possible bracing for the chords of the cantilever trusses;—a circumstance which is another advantage of this system.

A further novel form of the invention is illustrated in Figure 8, wherein supporting arches 12 and 12A are used instead of supporting trusses. Of these arches, 12 is the upper supporting arch and corresponds to the upper supporting truss 3, while 12A is the lower supporting arch and corresponds to the lower supporting truss 4. When arches are employed in this connection, the rises of the arches are adjusted so as to make the horizontal component of the thrust of the upper arch 12 equal and opposite to the thrust of the lower arch 12A so that the columns 6 receive only a vertical load as before.

The use of the invention is manifestly not limited to theatre construction and the supporting trusses or arches do not necessarily lie in the planes of the chords of the balcony trusses, but may lie in any intersecting planes neither of which is vertical.

The invention is equally applicable to concrete construction wherein the structural supporting trusses 3 and 4 are replaced by reinforced concrete girders or trusses or by the balcony and mezzanine floor slabs if reinforced to act as girders.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. Building construction embodying a truss to be supported, a fixed fulcrum on which said truss bears, a supporting truss extending transversely of the supported truss and secured to the cantilever truss and upon which supporting truss the supported truss bears in one direction, a second supporting truss also extending transversely of the supported truss but in a different plane than the first supporting truss, said second supporting truss being also secured to the supported truss and upon which second supporting truss the supported truss bears in a different direction than said supported truss bears on the first supporting truss, and means for anchoring the opposite ends of both the supporting trusses.

2. Building construction embodying a truss to be supported, a fixed fulcrum on which said truss bears, a supporting truss extending transversely of the supported truss and secured to the supported truss and upon which supporting truss the supported truss bears in one direction, a second supporting truss also extending transversely of the supported truss but in a different plane than the first supporting truss, said second supporting truss being also secured to the supported truss and upon which second supporting truss the supported truss bears in a different direction than said supported truss bears on the first supporting truss, and means for supporting the supporting trusses, said means including fixed supports positioned at the intersection of the planes of both supporting trusses and to which fixed supports the supporting trusses are connected.

3. Building construction embodying a truss to be supported, a fixed fulcrum on which said truss bears, a top supporting truss extending transversely of the supported truss and secured to the supported truss and upon which supporting truss the supported truss bears in one direction, a bottom supporting truss also extending transversely of the supported truss, but in a plane intersecting the top supporting truss, said bottom supporting truss being also secured to the supported truss and upon which bottom supporting truss the supported truss bears in a different direction than said supported truss bears on the top supporting truss, and vertical reaction elements for supporting the top and bottom supporting trusses at the intersection of the planes of said supporting trusses and to which vertical reaction elements the top and bottom trusses are secured, the load imposed by the supported truss on the bottom supporting truss constituting a substantial balance of the horizontal component of the load imposed by the supported truss on the top supporting truss, whereby the load on the vertical reaction elements is in a vertical direction.

4. Building construction embodying a substantially vertical truss to be supported, a fixed fulcrum on which said truss bears, a supporting truss extending transversely of the supported truss and secured to the sup-

ported truss and upon which supporting truss the supported truss bears in one direction, a second supporting truss also extending transversely of the supported truss but in a different plane than the first supporting truss, said second supporting truss being also secured to the supported truss and upon which second supporting truss the supported truss bears in a different direction than the supported truss bears on the first supporting truss, and means for supporting both the supporting trusses, said means including vertical reaction elements positioned at the intersection of the planes of the supporting trusses, and connecting elements interposed between the supporting trusses and the vertical reaction elements, the connecting elements of one of the supporting trusses being compression components and the connecting elements of the other supporting truss being balanced tension components, whereby the vertical reaction elements are exposed only to substantially vertical loads.

5. Building construction embodying a truss to be supported, a fixed fulcrum on which the supported truss bears, a supporting truss lying in a plane perpendicular to the plane of the supported truss and upon which the supported truss bears in one direction, a bottom supporting truss lying in a plane perpendicular to the plane of the supported truss, with the plane of the bottom supporting truss intersecting the plane of the top supporting truss, and upon which bottom supporting truss the supported truss bears in a different direction than the supported truss bears on the top supporting truss, two top connecting members whose axes lie in the plane of the top supporting truss and are parallel to the plane of the supported truss, and upon which members the top supporting truss bears, two bottom connecting members whose axes lie in the plane of the bottom supporting truss and are parallel to the plane of the supported truss and upon which members the bottom supporting truss bears, said latter connecting members intersecting the corresponding top connecting members and being connected to the top connecting members at said points of intersection, and two supports upon which the top and bottom connecting members bear at their points of intersection.

6. Building construction embodying a substantially vertical truss to be supported, a fixed fulcrum on which said truss bears, a supporting truss extending transversely of the supported truss and secured to the supported truss and upon which supporting truss the supported truss bears in one direction, a second supporting truss also extending transversely of the supported truss but in a different plane than the first supporting truss, said second supporting truss being also secured to the supported truss and upon which second supporting truss the supported truss bears in a different direction than the supported truss bears on the first supporting truss, said two supporting trusses having a common chord positioned at the intersection of the planes of the supporting trusses, and supports located at points in the common chord of the top and bottom supporting trusses, and upon which the top and bottom supporting trusses bear.

7. Building construction embodying a truss to be supported, a fixed fulcrum on which the supported truss bears, an arch extending transversely of the supported truss and secured to the supported truss and upon which the supported truss bears in one direction, a second arch also extending transversely of the supported truss but in a different plane than the first arch, said second arch being also secured to the supported truss and upon which the supported truss bears in a different direction than said supported truss bears on the first arch, and means for supporting both arches, said means including fixed supports positioned at the intersection of the planes of the arches and to which both arches are connected.

8. Building construction embodying a truss to be supported, a fixed fulcrum on which said truss bears, a beam component extending transversely of the supported truss and secured to the supported truss and upon which component the truss bears in one direction, a second beam component also extending transversely of the supported truss but in a different plane than the first component, said second component being also secured to the supported truss and upon which second component the supported truss bears in a different direction than said supported truss bears on the first component, and means for supporting the beam components, said means including fixed supports positioned at the intersection of the planes of both components and to which fixed supports the beam components are connected.

WALTER S. ST. JOHN.