United States Patent [19]

Love et al.

[11] **3,793,790**

[45] **Feb. 26, 1974**

[54] **FRAME CONSTRUCTION WITH YIELDABLE KNEE BRACE CONNECTION**

[75] Inventors: **Samuel L. Love**, Overland Park, Kans.; **Paul E. Swain**, Grain Valley, Mo.

[73] Assignee: **Butler Manufacturing Company**, Kansas City, Mo.

[22] Filed: **May 2, 1972**

[21] Appl. No.: **249,505**

[52] **U.S. Cl.** **52/393**, 52/693

[51] **Int. Cl.** **E04c 3/02**, E04b 1/36

[58] **Field of Search** 52/656, 393, 690, 693, 167; 248/15

[56] **References Cited**

UNITED STATES PATENTS

3,691,712	9/1972	Bowling et al.	52/393
2,860,743	11/1958	Cliff	52/693 X
2,715,510	8/1955	Fillion	248/15 X
3,073,065	1/1963	Alderman et al.	52/167 X

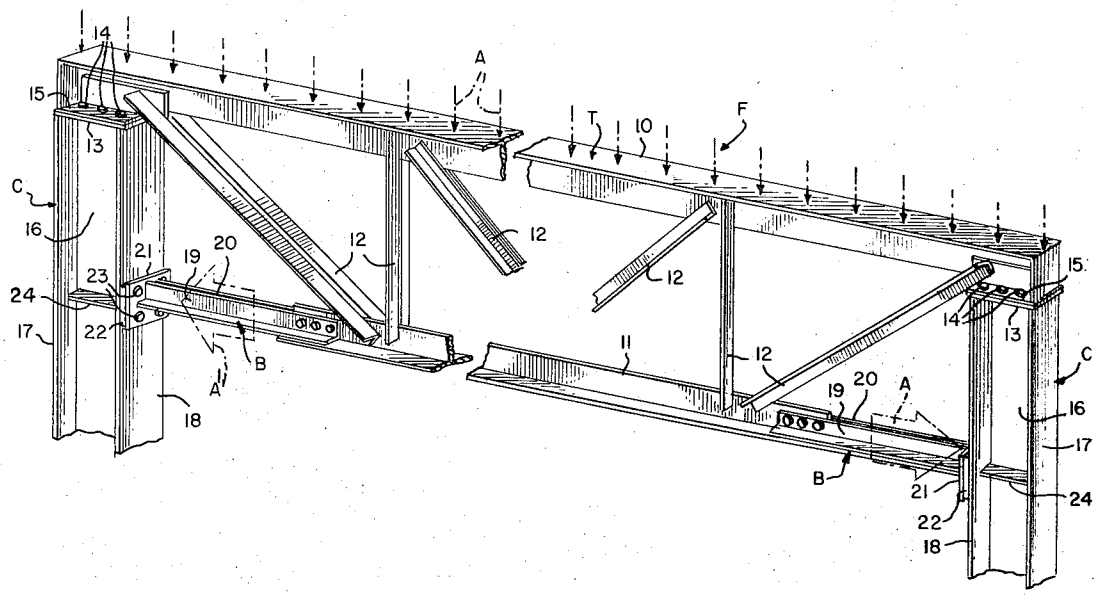
Primary Examiner—Price C. Faw, Jr.

Attorney, Agent, or Firm—Shoemaker and Mattare

[57] **ABSTRACT**

A frame construction with a yieldable knee brace connection comprising a beam truss means having a top chord and a bottom chord, the top chord of said beam truss means supported at least at one end thereof adjacent the top of a vertically extending column means, at least one knee brace means connected to and extending from one end of the bottom chord to the adjacent side of said vertically extending column means, and means operatively associated with said knee brace means to absorb horizontal deflection of said bottom chord and thus prevent bending of said vertically extending column means.

10 Claims, 5 Drawing Figures



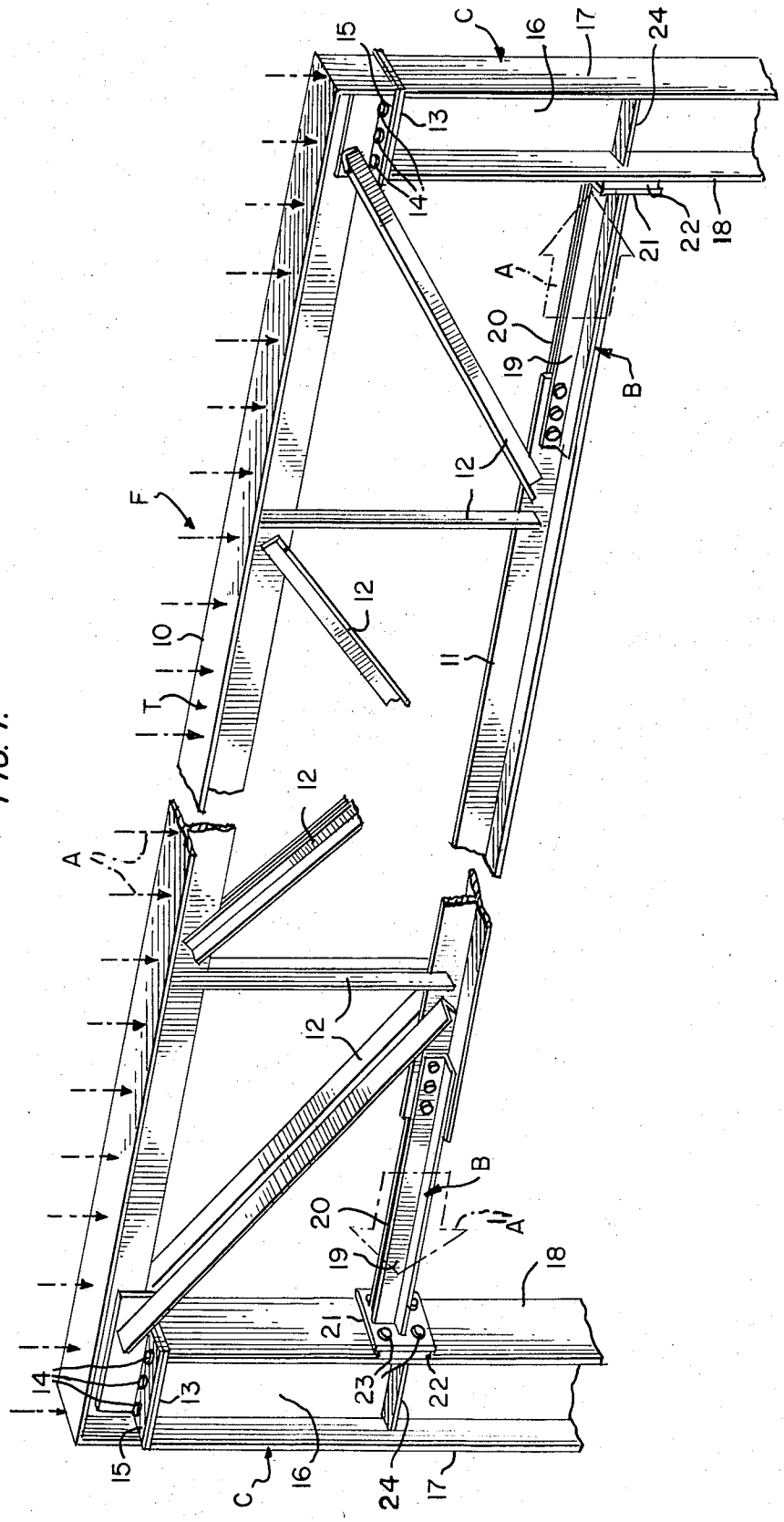

C
15
16
17
24
13
14
21
22
18
A
20
19
B
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F
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T
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A
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FIG. 1.

FIG. 2.

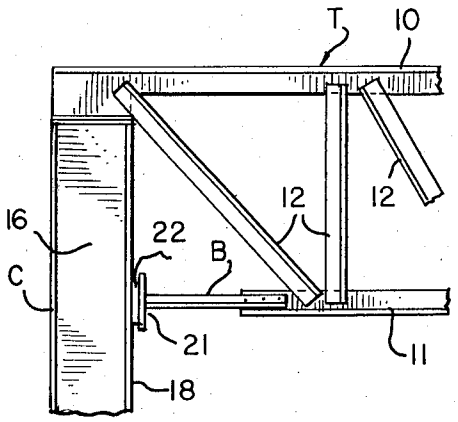


FIG. 3.

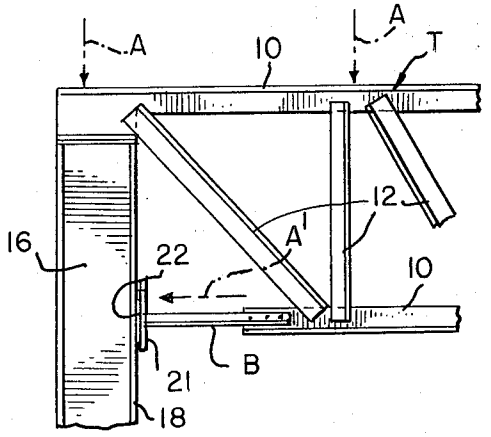


FIG. 4.

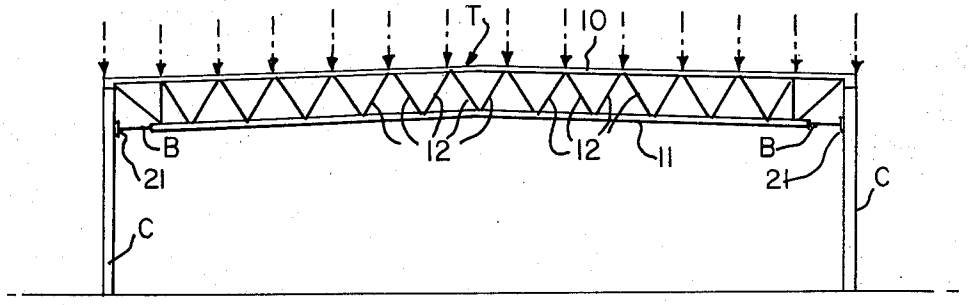
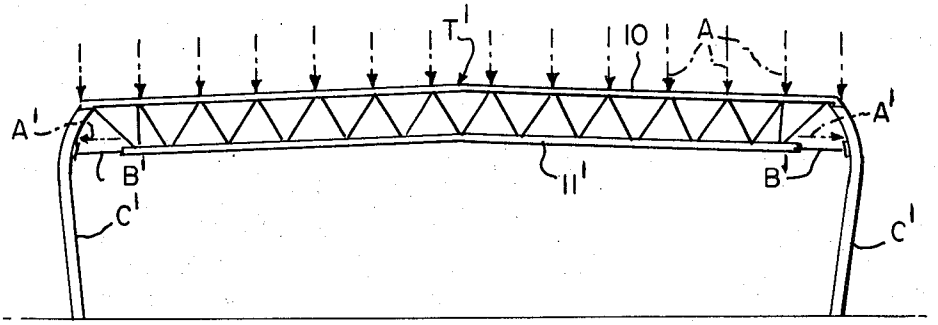


FIG. 5. PRIOR ART



FRAME CONSTRUCTION WITH YIELDABLE KNEE BRACE CONNECTION

BACKGROUND OF THE INVENTION

This invention relates to a means of connection between a beam truss and its supporting columns to absorb horizontal deflections of said beam truss and thus prevent bending of said columns.

Conventional engineering practice in the design of buildings, as for example, in the design of mill buildings, is to design the beam truss for maximum vertical loading with the truss designed as a simply supported beam. The columns on which the truss is supported are designed for the resulting axial or vertical load thereon from the beam truss, and in order to provide resistance to side loading, such as wind loading and the like, a brace is added between the lower chord of the beam truss and the adjacent side of the supporting column. Vertical loading on the beam truss causes vertical displacement of at least the center portion thereof and the lower chord of the beam truss is accordingly displaced horizontally toward the columns. The brace extending between the bottom chord and the column resists this horizontal displacement and causes a compressive force in the brace, thus bending the column. Frequently, this bending of the column is larger than that for which the column is designed. It is common practice in the prior art to ignore this over stressing of the column and to use compact mill wide flange columns and design the trusses with moments of inertia 80 to 100 times greater than that of the supporting columns. The resulting structure is a plastic design forming in effect a "hinge" in the columns at the brace location. The material in this localized region yields and flows plactically to allow the required deformation of the columns without damage thereto.

If non-compact fabricated H-section columns, and trusses with decreased depth and therefore less moment of inertia that those of conventional design, are used in the building construction, then there is a possibility of over stressing of the columns.

By means of the present invention, the above problems are ecomonically and effectively solved. In the present invention a yieldable connection is provided in operative association with the brace extending from the bottom chord of the beam truss to the adjacent side of the vertical support column. This yieldable connection absorbs the horizontal deflection of the bottom chord and thus prevents bending of the supporting column. More particularly, in accordance with the present invention, a yieldable deflection pad is interposed between the end of the brace and the adjacent side of the vertical column, and this yieldable pad absorbs the horizontal movement of the bottom chord under vertical loading of the beam truss, thereby preventing bending of the column. The pad is sufficiently rigid, however, to provide adequate bracing against side sway due to wind loading and the like.

The invention thus provides a frame construction which results in a structurally sound and economical column design for fabricated H-section columns.

OBJECTS OF THE INVENTION

It is an object of this invention to provide a structurally sound and economical frame design which permits the use of fabricated H-section columns.

Another object of this invention is to provide a frame construction having a beam truss means and supporting column means wherein a brace means extends from the bottom chord of the beam truss means to the supporting column means and means is operatively associated with the brace means for absorbing horizontal deflection of the bottom chord to prevent bending of the column means.

A further object of this invention is to provide a frame construction having a beam truss means with a top chord and a bottom chord and supported on vertical column means, and wherein a knee brace means is connected between the bottom chord and the adjacent side of said column means with a yieldable deflection pad connected between one end of the knee brace and the adjacent side of a support column to absorb horizontal deflection of said bottom chord due to vertical loading on said beam truss, and thus prevent bending of said column.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top perspective view with a portion broken away from a frame construction in accordance with the present invention.

FIG. 2 is a fragmentary view in elevation of a portion of the frame means of FIG. 1, with the frame in unloaded condition.

FIG. 3 is a view similar to FIG. 2 with the frame in loaded condition.

FIG. 4 is a view in elevation of the frame means of FIG. 1 with a vertical load applied to the beam truss.

FIG. 5 is a view similar to FIG. 4 of a prior art construction with a vertical load applied to the beam truss and showing the bending of the vertical support columns.

DETAILED DESCRIPTION OF THE INVENTION

In the drawings, wherein like reference numerals indicate like parts throughout the several views, a frame construction is indicated generally at F in FIG. 1 and comprises a beam truss T and supporting columns C. The beam truss T comprises a top chord **10** having a T-shaped cross sectional configuration and a bottom chord **11** having an inverted T-shaped cross sectional configuration. The bottom chord **11** is shorter in length than the top chord **10**, and a plurality of brace means **12** are connected at their opposite ends to the top and bottom chords **10** and **11**, respectively.

The opposite ends of the top chord **10** extend over the upper ends of the vertical support columns C and are attached to flanges **13** on the upper ends of the support columns C by means of a plurality of bolts or rivets or the like **14** extended through a flange **15** on the end of the top chord **10** and through the flange **13** on the tops of columns C. The columns C are of fabricated H-section design with a web **16** extending parallel to the axis of the beam truss T, and an outside flange **17** and an inside flange **18**. A knee brace B is connected between the opposite ends of the bottom chord **11** and the inside flange **18** of the adjacent column C at the opposite ends of the beam truss T.

Each knee brace B comprises a pair of angle members **19** and **20** bolted or otherwise suitably secured at one end thereof to one end of the bottom chord **11** on opposite sides of the web thereof. A plate **21** is welded or otherwise suitably fixed to the other end of the angle members **19** and **20** at a right angle to the axes thereof

and a yieldable deflection pad 22 of substantially the same height and width as the plate 21 is interposed between the plate 21 and the inside flange 18 of the column C. A plurality of bolts or rivets or the like 23 extend through the plate 21 and the inside flage 18 of the column to connect the knee brace B to the adjacent column C. As seen clearly in FIG. 1, a stiffening plate 24 may be fixed between the flanges 17 and 18 of the columns C at the location of attachment of the deflection pads to aid the columns in resisting the force transmitted thereto through the deflection pads. In a preferred construction, the deflection pad is made of any suitable, commercially available elastomeric material, such as natural rubber, and has a size of 6 inches by 6 inches by 1 inch. The pad preferably has a durometer of 70 (type A) at 70° F. and a minimum tensile strength of about 3,500 psi, and is secured with four seven-eighths inch bolts in fifteen-sixteenth inch holes. Thus secured, the pad has a modulus of 3.6 ksi at 55°.

As seen in FIGS. 1, 3 and 4, when a vertical load is applied to the beam truss T as indicated by the arrows A, the bottom chord 11 is deflected horizontally toward the columns C, thus exerting a compressive load through the knee brace B as indicated by the arrows A'. In the absence of the yieldable deflection pad 22, this compressive load A' is exerted against the side of columns C, tending to bend or deflect the columns, and in some cases may overstress the column.

As viewed in FIG. 2, the beam truss T does not have any load applied to it, and the yieldable deflection pad 22 is at its full thickness.

In FIG. 3, a vertical load is applied to the beam truss T and the bottom chord 11 is accordingly horizontally deflected, placing a compressive force in the knee brace B and the yieldable deflection pad 22. The deflection pad 22 yields or deflects commensurate with the load applied thereto, and thus absorbs the horizontal deflection of the bottom chord, preventing bending and possible damage of the columns C, and yet providing sufficient rigidity or stiffness to resist side sway due to wind loading and the like.

In FIG. 5, a conventional beam truss T' is shown subjected to a vertical load indicated by the arrows A and a compressive force A' is shown being exerted through a conventional knee brace B' into the vertical support columns C', and bending the columns C' due to the rigid connection between the ends of bottom chord 11, the knee braces B' and columns C'.

The present invention can be used in various combinations of truss spans, column heights and vertical and horizontal loadings to achieve economical design of the columns and frame construction. The yieldable deflection pad is preferably formed of an elastomeric material having the capability of recovering after sustained loading and of resisting age hardening or corrosion from exposure to ozone or the like. Further, the yieldable deflection pad should be made of a material capable of withstanding a large percentage of compression and be operative over a wide temperature range and durable even under large cycling of loads thereon. In a typical installation, the deflection pad 22 has a normal thickness of about 1 inch in unloaded condition, and a thickness of less than 1 inch in loaded condition, depending on the amount of the load.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents, are therefore intended to be embraced by those claims.

What is claimed is:

1. A frame construction for absorbing horizontal deflection of a bottom chord of a beam truss means due to vertical loading on the beam truss means to prevent bending of a column means on which said beam truss means is supported, said beam truss means having a top chord and a bottom chord, the top chord of said beam truss means supported at least at one end thereof adjacent the top of a vertically extending, H-section column means, knee brace means fixedly connected at one end thereof to one end of the bottom chord and extending at its outer end into proximity with an adjacent side of said vertically extending column means, an elastomeric deflection pad engaged between the other end of said knee brace means and said comumn means and acting in compression to absorb horizontal deflection of said bottom chord due to vertical deflection of said beam truss means as a result of vertical loading on said beam truss means, and fastening means extended through said knee brace means, said deflection pad and an adjacent portion of said column means to secure the knee brace means and deflection pad to the column means, said pad thus absorbing horizontal deflections of said bottom chord due to vertical loading on said beam truss means and thus preventing bending of said vertically extending column means, while at the same time the pad has sufficient rigidity to provide bracing against side loading due to wind and the like, said H-section column means having a web with oppositely directed flanges at the opposite edges thereof, and a stiffening means secured between the flanges of the column at the location of attachment of the deflection pad thereto to aid the column in resisting the force transmitted thereto through said deflection pad.

2. A frame construction as in claim 1, wherein said stiffening means comprises a plate secured between the flanges of the column.

3. A frame construction as in claim 1, wherein the top chord is supported at both ends on the tops of a pair of vertical support columns, a knee brace extends from each of the bottom chord to the adjacent side of an adjacent column, and a deflection pad for absorbing horizontal deflections of said bottom chord is operatively connected with each said knee brace.

4. A frame construction as in claim 2, wherein said bottom chord is of substantially less length than said top chord and each said knee brace comprises a pair of angle members connected at one end thereof to one end of said bottom chord and connected at the other end thereof to the adjacent side of said vertically extending column means.

5. A frame construction as in claim 3, wherein a rectangular plate is fixed to said other end of each said knee brace at right angles to the axis thereof, and said deflection pad is rectangular in shape and substantially commensurate in size with said plate, said plate distributing the conpressive loading imparted thereto from said knee brace over the entire area of said yieldable deflection pad.

6. A frame construction as in claim 5, wherein said deflection pad is made of natural rubber.

7. A frame construction as in claim 6, wherein said deflection pad has a size of 6 inches by 6 inches by 1 inch and is secured with four seven-eights inch bolts extended through fifteen-sixteenths inch holes.

8. A frame construction as in claim 7, wherein the deflection pad has a durometer of 70 (type A) at 70°F, a minimum tensile strength of 3,500 psi, and a modulus of 3.6 ksi at 55°.

9. A frame construction as in claim 1, wherein said pad is directly engaged at its opposite sides with said plate and with the adjacent portion of said column means, respectively.

10. A frame construction as in claim 1, wherein said deflection pad is secured in position by said fastening means is capable of absorbing substantially only ocmpressive force.

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