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PRESTRESSED LOAD-BEARING BEAM STRUCTURE

Filed April 6, 1959

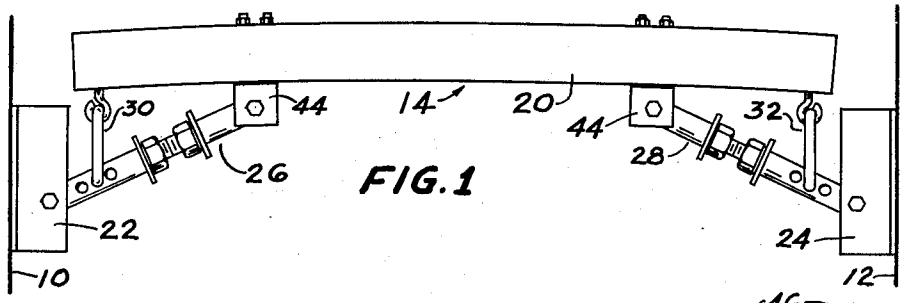


FIG. 1

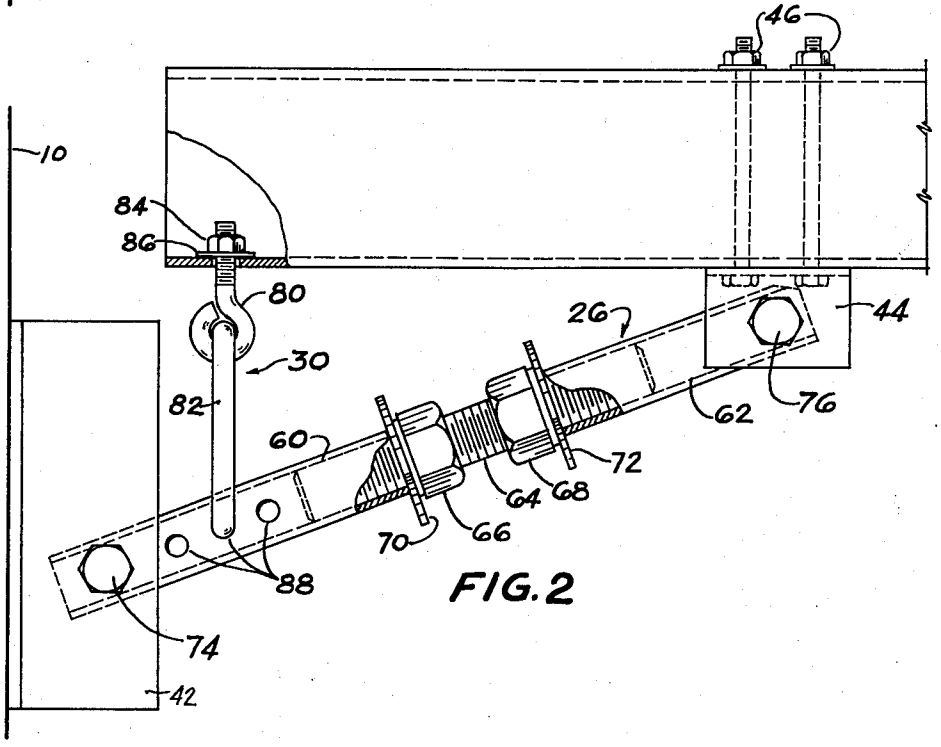


FIG. 2

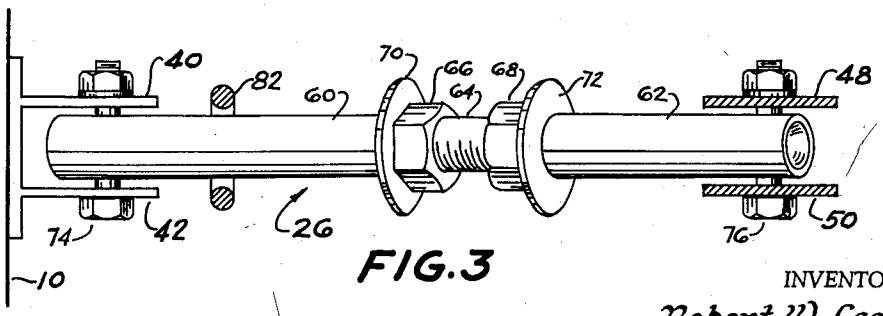


FIG. 3

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PRESTRESSED LOAD-BEARING BEAM STRUCTURE

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This invention relates to a prestressed load-bearing beam structure. It constitutes an improvement over the structural beam disclosed and claimed in my copending patent application Serial No. 742,391, filed June 20, 1958.

Load-bearing beams of the general character under discussion are used to support ceilings, ceiling fixtures, false or hanging ceilings, roofs and the like. These beams may be embodied in both temporary and permanent installations. For example, they may be used to support false ceilings installed for temporary use in exhibition halls. By the same token, they may be incorporated into permanent ceilings and roofs of permanent building structures.

The principal object of this invention is the provision of a prestressed structural beam which combines relatively great structural strength with relatively light weight. A beam structure of substantially the same dimensions and proportions, made of the same material, but lacking the prestressing feature of the present invention, would support far less weight than a prestressed beam structure of the character herein described and claimed. Moreover, a beam structure which is not prestressed tends to sag and become deformed under a substantial load applied to its unsupported portions. A prestressed beam structure as herein disclosed, on the other hand, provides great resistance to deformation under a load. Moreover, such deformation as does take place merely returns it to the position which it occupied prior to application of the prestressing forces. Stated differently, the stress imposed by the load must first cancel out the stress imposed by the prestressing procedure before sagging can take place.

An important feature of this invention is the arch-type structure which results from the prestressing action. The structure corresponds to a relatively wide arch whose curvature is almost imperceptible. Nonetheless, it functions in the manner of a true arch in the sense that it translates the downward force of the load into divided lateral forces exerted in opposite directions away from each other. This feature leads to the second object of this invention which is to support the prestressed beam herein claimed on a pair of oppositely disposed vertical supports. The conventional means for supporting a horizontal beam is a pair of horizontal supports disposed at opposite ends thereof, spaced a smaller distance apart than the length of the beam which they support. In the present invention on the other hand, the ends of the beam structure, and more particularly its prestressing elements, are supported on vertical structures which are spaced apart a distance corresponding to the overall length of the beam structure in its installed condition. This feature is not intended to exclude any and all forms of horizontal support under any and all conditions. It may be found necessary or desirable at certain times and for certain purposes to add horizontal supports to

the vertical supports herein described. But such horizontal supports would be auxiliary or supplementary to the vertical supports which are essential to the proper functioning of this invention.

Another important feature of this invention is the fact that the prestressing procedure is applied at the time of or following installation; it is not performed as a part of the manufacturing or fabricating process. The beam is not prestressed until it is actually installed and prestressing may be delayed until any predetermined time or phase of construction following installation.

A further object of this invention is its preloading feature which solidifies installation prior to the application of a load. Since the beam structure which is herein claimed is not inherently prestressed as a separate, independent unit, the process of prestressing must include the structural supports of the beam. It would be difficult, perhaps impossible under certain conditions, to prestress a beam of this type without the benefit of the preloading procedure. It is the combination of the prestressing and preloading aspects of this invention which provides it with its greatest advantages.

The invention is illustrated in the accompanying drawing in which:

Fig. 1 is a side view of a beam structure made in accordance with this invention, showing it installed between a pair of spaced vertical supports.

Fig. 2 is an enlarged, fragmentary view of one end of said beam support, partly broken away, to show the details of one of the prestressing elements.

Fig. 3 is a horizontal section looking downwardly on one of the prestressing supports.

Referring now to the drawing, vertical supports **10** and **12** are intended to illustrate any suitable supporting elements such as the opposite walls of a building or of a room within a building or a pair of horizontally spaced vertical columns or frames in the structural framework of a building. It is important that these supporting elements be adapted to support a load which of course would exert a downward force and also lateral or horizontal forces exerted leftwardly upon supporting element **10** and rightwardly upon supporting element **12**.

The prestressed beam structure **14** herein claimed comprises the following component parts: a beam proper **20**, a pair of pressure plates or pads **22** and **24** respectively, a pair of screw-adjustable prestressing members **26** and **28** respectively, and a pair of screw-adjustable preloading members **30** and **32** respectively.

Turning now to the details of construction of the illustrated form of the invention, it will be understood that beam **20** may be made of any suitable material and in any suitable shape. For example, it may be made of structural steel or aluminum, the latter where weight is a factor. The cross-sectional shape of the beam is not critical and one preferred shape would be rectangular to form a box-type structure.

By the same token, plates of pads **22** and **24** may be made in any suitable form and of any suitable material. Steel and aluminum are good illustrations. These pads are provided preferably, with a pair of vertically extending flanges **40** and **42** respectively which not only strengthen and stiffen the pads proper but also serve as the means by which the prestressing elements are connected to and supported by said pads. The pads may be secured to the vertical supports **10** and **12** by any suitable means, such as cement, rivets, bolts or by simply being placed against said vertical supports and held there by the lateral forces above mentioned.

Secured to the beam adjacent each end thereof is a bracket **44** of generally inverted U shape. The yoke of

each bracket 44 abuts the bottom wall of the beam and is secured to the beam by means of bolts 46. The adjustable prestressing members 26 and 28 are disposed at their respective end portions between flanges 40 and 42 of the pressure pads or plates and the corresponding flanges 48 and 50 of brackets 44. More specifically, and referring by way of illustration to adjustable prestressing member 26 (the same remarks apply to prestressing member 28) it will be noted that said prestressing member comprises a pair of tubular members 60 and 62 respectively, a thrust screw 64 projecting at its ends into said tubular members, a pair of nuts 66 and 68 threaded on said screw in the space between said tubular members, a pair of washers 70 and 72 disposed between said nuts and the adjacent ends of said tubular members, and a pair of bolts 74 and 76 respectively which attach the outer ends of said tubular members to flanges 40 and 42 of the pressure pads on the one hand and flanges 48 and 50 of brackets 44 on the other hand.

Before describing the operation of these prestressing members, it is necessary to describe the construction, operation and function of the preloading members 30 and 32. By way of illustration preloading member 30 comprises an eye-bolt 80 and a link 82. The threaded shank of the eye-bolt projects through a hole in the bottom wall of beam 20, immediately adjacent its end, and a nut 84 supports the shank on said bottom wall. A washer 86 may be interposed between said nut 84 and said bottom wall of the beam to facilitate the action as will shortly appear. The upper end of link 82 is looped or hooked through the eye of eye-bolt 80. The lower end of said link is looped or hooked through any one of several holes 88 in tubular member 60. Several such holes are formed to provide for adjustability although only one hole is used at any given time.

The beam is installed by placing it between a pair of vertical supports such as 10 and 11 as shown in Fig. 1. In the event that pressure pads 22 and 24 are not firmly secured to said vertical supports 10 and 12, as by means of bolts, but instead are merely held against said vertical supports, it becomes necessary to preload the entire beam structure in order to provide the necessary lateral or horizontal holding forces. This is done by tightening the preloading members 30 and 32 to draw the corresponding ends of the beam and of the prestressing members closer together. The prestressing members will of course pivot about their respective bolts 76, prestressing member 26 in clockwise direction and prestressing member 28 in counter-clockwise direction. This will create the necessary outward lateral forces which will jam or wedge the entire beam structure in place. In effect, the prestressing members 26 and 28 function in the manner of toggle elements between the beam proper and the pressure pads, thereby setting up the lateral forces necessary to do the job.

Once the beam structure is securely held in place, the prestressing members may be extended in length to provide an upward thrust against the beam along their respective axes. This may be done by adjusting the relative positions of nuts 66 and 68 in order to move them farther apart. This will cause elongation of the prestressing members and provide the upward thrust forces above mentioned. The result will be to bow the beam in the manner shown in Fig. 1. To the extent necessary, preloading members 30 and 32 may also be tightened following the prestressing operation last described. The beam structure is now completely installed and ready for use.

The foregoing is illustrative of a preferred form of this invention and it will be understood that this form may be modified and other forms may be provided within the broad principles of the invention and the scope of the claims.

For example, it is not essential that washers 70 and 72 be interposed, as shown, between nuts 66 and 68 on the one hand and tubular members 60 and 62 on the other hand. These washers are merely bearings which provide

a more secure relationship between the nuts and the tubular members and also facilitate rotation of said nuts relative to said tubular members under a load. The same situation obtains with respect to washers 86 which help distribute the force exerted by the preloading members over a larger area of the bottom wall or web of the beam. These washers also facilitate rotation of nuts 84 under a heavy load. Nonetheless, the structure will function without such washers 86. By the same token, the invention is not limited to the precise shape of the various elements shown. By way of illustration, it is not essential that the precise screw adjusting means in both the prestressing and preloading members be used. Other forms of screw adjusting means may also be used.

I claim:

1. A beam structure of the character described, comprising a beam adapted to be supported in horizontal position between a pair of vertically disposed structural supports, a pair of oppositely inclined prestressing members disposed below said beam and converging at their upper ends and diverging at their lower ends, said prestressing members being secured at their upper converging ends to said beam inwardly of its ends, a pair of vertically disposed pressure pads secured to the lower diverging ends of said prestressing members and adapted to engage said structural supports, and a pair of preloading members secured at their upper ends to the ends of said beam and at their lower ends to the lower diverging ends of said prestressing members, said prestressing members being longitudinally extensible to apply upward forces upon the beam inwardly of its ends, said preloading members being longitudinally contractible to apply downward forces upon the ends of the beam, whereby the beam may be caused to bow upwardly in prestressed condition.

2. A beam structure in accordance with claim 1, wherein the prestressing members are longitudinally adjustable, each said prestressing member comprising a pair of longitudinally spaced and aligned tubes, a screw between said tubes and projecting at one end into one of said tubes and at the other end into the other of said tubes, and a pair of nuts on said screw, one of said nuts engaging one of said tubes and the other of said nuts engaging the other of said tubes.

3. A beam structure in accordance with claim 2, wherein vertically extending brackets are provided on the beam and on the pressure pads, the tubes of said prestressing members being pivotally secured to said brackets for pivotal movement about parallel horizontal axes.

4. A beam structure in accordance with claim 1, wherein the preloading members each comprise an eye-bolt adjustably secured to the beam and a link adjustably secured to the prestressing member, said eye-bolt and said link being interconnected.

5. A beam structure in accordance with claim 4, wherein the beam is provided with a bottom wall, each said eye-bolt projecting through said bottom wall with its threaded shank, the eye projecting downwardly from said bottom wall, and a nut on said threaded shank which engages the top of said bottom wall.

6. A beam structure in accordance with claim 4, wherein each prestressing member is provided with a plurality of holes formed therein adjacent its lower diverging end, the link of the corresponding preloading member being selectively engageable with said holes.

7. A beam structure of the character described, comprising a beam adapted to be supported in horizontal position between a pair of vertically disposed structural supports, a pair of pressure pads being adapted to be secured to said structural supports adjacent and below the ends of said beam, a pair of oppositely inclined prestressing members attached at their lower ends to said pressure pads and at their upper ends to said beam inwardly of the ends of the beam, and a pair of preloading members secured at their upper ends to the ends of the beam and at their lower ends to the lower ends of the prestressing members, said preloading members being

vertically adjustable to draw the ends of the beam and the lower ends of the prestressing members toward each other in order to apply horizontal forces to the pressure pads jamming them against the vertically disposed structural supports and thereby supporting the beam thereon, said prestressing members being longitudinally extensible to apply upward forces upon the beam intermediate its ends and thereby causing the beam to bow upwardly in prestressed condition.

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