Jan. 1, 1963 D. B. CHESKIN 3,070,845

PRETENSIONED MULTIPLE SPAN BEAM SYSTEM

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Figure 1

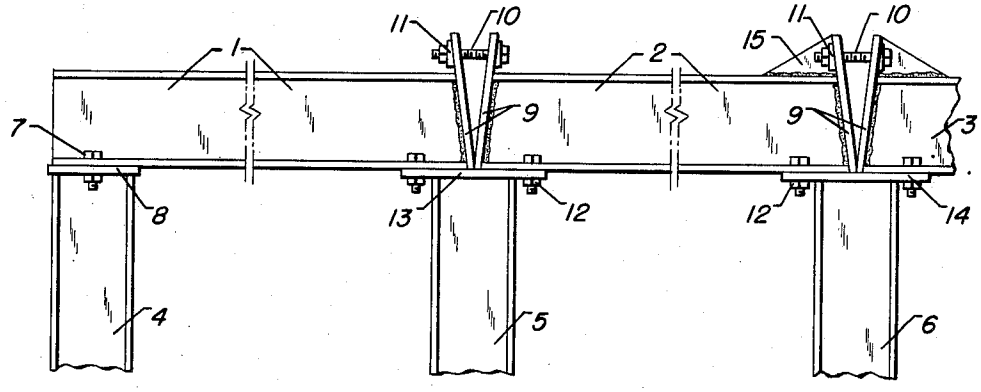


Figure 2

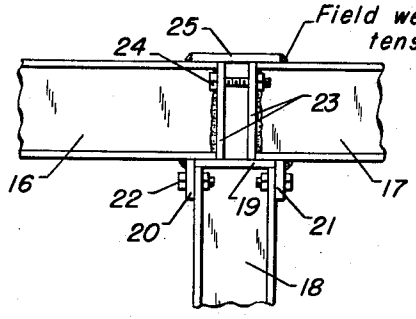


Figure 3

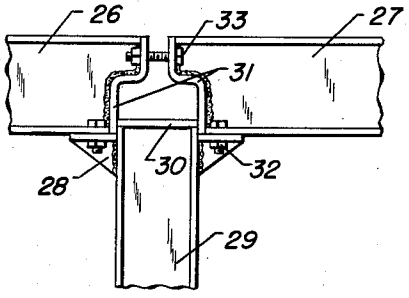


Figure 4

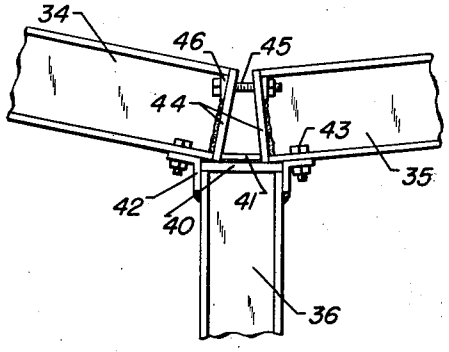
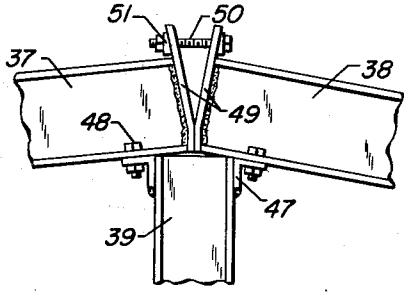


Figure 5



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PRETENSIONED MULTIPLE SPAN BEAM SYSTEM

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Figure 6

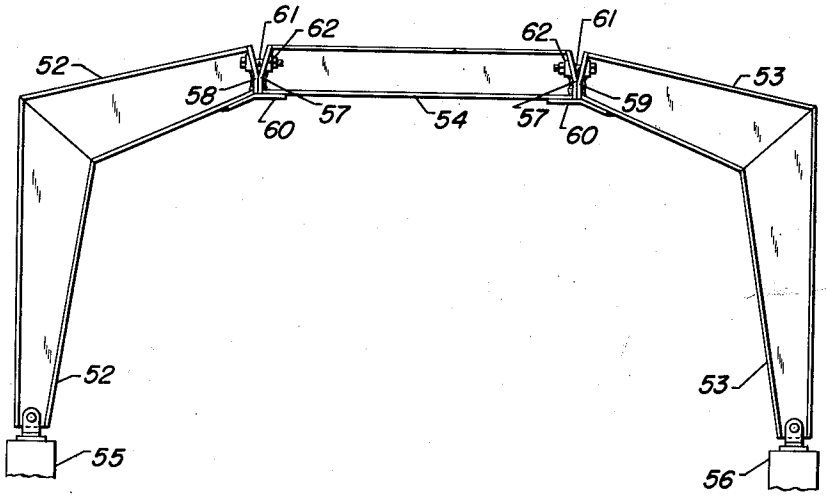


Figure 7

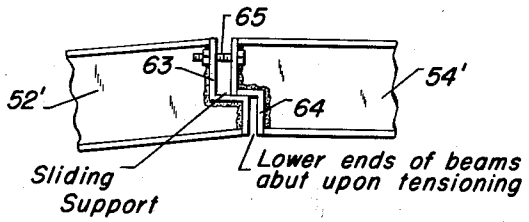
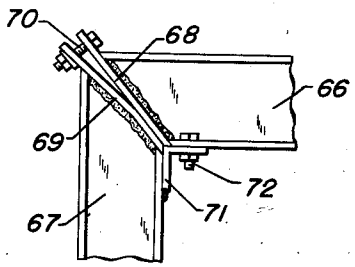


Figure 8



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PRETENSIONED MULTIPLE SPAN BEAM SYSTEM

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This invention relates to a multiple beam system providing tension and camber therein prior to its being subjected to loading. More particularly the system provides means for effecting the tensioning in a simple manner during the erection of the integrated system.

A principle object of the invention is to provide a simple method for pretensioning steel beam systems whereby each beam of the system is provided with tension in the top portion thereof prior to use or loading and thus can subsequently accommodate far greater loads than would normally be possible by a simply supported beam over the same span.

A further object of the invention is to provide a simple field assembly system for steel beams where camber and pretensioning is accomplished after placement thereof.

The great advantage of the system is of course that smaller, or lesser depth, beam sections can be utilized to accommodate the given loadings and still stay well within the elastic limits of the sections being used.

The system utilized depends in turn upon the use of at least two adjoining beam sections which may form at least part of a building frame, or alternatively, sections which extend over at least two spans and three supports, one of which is an intermediate support.

Briefly the invention may be said to comprise a multiple beam section system providing tension in the top portions thereof and resulting camber, which comprises in combination, means supporting and aligning the ends of adjacent beam sections one with the other, said supporting and aligning means abutting the lower portions of the ends of adjacent beam sections, anchoring means at the extremities of the multiple section system, spaced apart upper portions of the ends of adjacent beam sections, and adjustable tensioning means connecting the spaced apart upper portions of the sections, whereby the tightening of the tensioning means effect tension in the top portions of the sections and resulting camber therein.

In another embodiment the present invention comprises a multiple beam system over a plurality of supports providing tension in the top portions thereof and resulting camber in each, said system comprising in combination, spaced supporting means at the lower end portions of each beam extending over each span, bearing means aligning and abutting the lower end portions of adjacent beams, anchoring means at the outer ends of the terminal beams of a system fixedly connecting the latter to the outside supports of the plurality thereof, spaced apart upper portions of adjacent beams, and adjustable tensioning means connecting the spaced apart upper portions of said adjacent beams, whereby the tightening of said tensioning means effects tension in the top portions of the beams and resulting camber therein.

As will be subsequently described more completely, various means and devices may be provided to provide aligning and abutting means at the lower end portions of the beams whereby they may press against each other during the pretensioning process. Also, various adjustable tensioning means may be provided to connect the upper end portions of adjacent beams so that one section will pull against the other and resulting tension be effected in each of the series of the system. Generally bolts or clamping means are readily adaptable for use as the tensioning means between beam sections.

Reference to the drawing and the following description thereof will serve to more clearly set forth the method and means for pretensioning a multiple span beam system.

FIGURE 1 of the drawing is a diagrammatic elevational view of multiple beams over multiple supports with suitable connecting means providing pretensioning of the beams.

FIGURES 2 and 3 show modified abutting and connecting means for use over intermediate supports.

FIGURES 4 and 5 illustrate still other abutting and tensioning means for use over intermediate supports as well as sloping beam sections such as might be used in various roof constructions.

FIGURE 6 shows a diagrammatic elevational view of a multiple section frame, with no intermediate supports, which provides means for pretensioning and cambering the tops of the beam portions.

FIGURES 7 and 8 show still further abutting and connecting arrangements.

Referring now to FIGURE 1 of the drawing, there are shown beam sections **1**, **2** and **3** extending over and supported on supporting columns **4**, **5** and **6**, with the latter two being illustrated as intermediate columns and **4** as an outside column of the row thereof.

The outer end of the terminal beam **1** is bolted or otherwise fixedly attached to the top of the column **4**, such as by bolts **7** thru the flanges of beam **1** and the cap plate **8**.

The inside or interior end of beam **1** and the similar interior ends of beams **2** and **3** are provided with a slight taper and fixedly attached plates **9**. The plates **9** may be welded, as shown, bolted, riveted, or otherwise connected to the beams. Each plate **9**, in this embodiment, extends above the top flanges of the beam sections and are drilled or punched to accommodate one or more bolts **10** at each juncture between adjacent beam sections. The sloping beam ends and resulting non-vertically positioned plates **9** permit abutment of facing or opposing plates **9** along their lower edges whereby they may compress against each other as bolts **10** are tightened after erection and assembly of all beams over all spans, of a given building width. Tapered or beveled washers **11** may be used against sloping plates **9** and under the heads and nuts of the various bolts **10**. In order to erect and align adjacent beam over intermediate supports, suitable holes and rivets or bolts **12** may be used between flanges of the beams and the column cap plates **13** and **14** over respectively columns **5** and **6**. Also, where plates **9** extend above the top of the beam sections and it is structurally desirable or necessary to strengthen them because it is desired to use relatively thin plate sections, then suitable fillet plates, such as **15**, may be welded or otherwise connected between the top extensions of plates **9** and the top faces of the beams, such as shown at the ends of beams **2** and **3**.

In effecting the formation of the camber and the pretensioning in the multiple span system, it is necessary to place all beam sections across the width of the structure, in alignment, and abutting adjacent sections on their lower edges, as shown in FIGURE 1. Then after assembly, the tightening of bolts may being in a gradual and even manner in order to gradually bring substantially equalized tension to the top portion of all beam members. Preferably, tightening should be carried out symmetrically with respect to a center line of the building or structure. As for example, in the instance of three intermediate supports, the bolts over the supports next to the outside columns or walls should be tightened first and then the bolts over the center support lastly.

FIGURE 2 shows a modified means of effecting abut-

ment and tensioning between two adjacent beam members such as 16 and 17 over supporting column 18 having cap plate 19. In this embodiment the beam 16 has a lower lug member 20 attached thereto and beam 17 has a lower lug 21 attached to it. Each of the lugs may be bolted to the column by bolts 22 and provide means for the effective abutment of the lower portions of the ends of the adjacent beams 16 and 17, with compressive forces carrying through the top end of the column 18 and plate 19. End plates 23 are attached to the spaced apart ends of the two adjacent beams 16 and 17 and their upper portions are provided with suitable holes for bolts 24 such that tension may be effected between and in the top portions of the beam members. In this modified design for connecting the beams of the multiple beam system, the tensioning means are maintained just below the top flanges of the beams in order to provide a substantially smooth top surface to the system. Also, if desired, the bolts or other tensioning means need be used only temporarily at the beam junctures. For example, a plate 25 may be welded across the top of the end of beams 16 and 17 after pretensioning the beams.

It may be further pointed out, in an alternative type of assembly operation, that suitable removable adjustable clamping means may be used to pull the top portion of one beam against the other in lieu of bolts 24. Then, when the desired tension and camber is put into the top portions of all of the beams, the various plates 25 at all junctures can be field-welded or bolted into place and maintain the system under the desired pretensioning.

In FIGURE 3 of the drawing, abutment of the lower end portions of beams of system are shown in another manner, with beams 26 and 27 resting on brackets 28 near the top of column 29. The ends of the beams 26 and 27 are notched to fit over the top of column 27 and the cap plate 30. Shaped end plates 31 are welded or otherwise fixed to the ends of the beams 26 and 27. Bolts 32 serve to attach the beams to the brackets 28, whereby compressive forces can carry thru the top of the column from one beam to the other, and bolts 33 through the spaced apart portions of the end plates 31 provide for tensioning the top portions of the adjacent beams 26 and 27. Here again the bolts 33 are shown below the top surface of the beams to provide an unobstructed top surface for the beam members.

FIGURES 4 and 5 illustrate sloping beam arrangements, with downwardly sloping ends of beams 34 and 35 being supported on column 36, and the upwardly sloping ends of beams 37 and 38 are supported on a column 39. In FIGURE 4, the bottom ends of beams 34 and 35 rest on cap plate 40 and against the edges of bearing plate 41 which in turn is attached to the plate 40. The beams may be held in alignment at the column and against the bearing plate 41 by supporting clips 42 and bolts 43. A plate 44 on each of the spaced apart ends of beams 34 and 35 provide means for placing bolts 45 and tensioning the top fibers of these adjoining beams and also effecting the desired camber in the beams. Suitable beveled washers 46 may be used between the sloping plates 44 and the heads and nuts of bolts 45.

In FIGURE 5, the bottom ends of beams 37 and 38 rest on and are aligned by clips or brackets 47 and connecting bolts 48 at the top of the intermediate column 39. In this instance plates 49 at the ends of the beam members are shaped and fixedly attached to said beams so that they may directly abut and push against each other along the bottom portions of the beams. The spaced apart top portions of the plates 49 are provided with holes to accommodate bolts 50. Here again beveled washers 51 may be used between the slopping plates 49 and the heads and nuts of the bolts 50.

The frame system of FIGURE 6 shows three sections comprising end sections 52 and 53 and center beam section 54, after pretensioning has been applied. The end sections 52 and 53 are illustrated diagrammatically and not in any detail or actual scale. The lower ends of the combined column and beam sections 52 and 53 may be connected to lower bases or foundations 55 and 56 by anchor bolts or pivoted means. The beam section 54 is provided with end plates 57, while the beam portions of sections 52 and 53 are provided with, respectively, plates 58 and 59. Such plates may be welded or otherwise attached to the beam sections and of course should be bent or angled to provide abutment at their lower portions and spacing at their upper portions. Supporting plates 60 are provided at the juncture of beam 54 with the end sections whereby these intermediate end portions may be supported and aligned one with another. The plates 60 may be welded, as indicated, or bolted to the beam sections, making the final weld or fixed connection after the sections are tensioned. Bolts 61, with beveled washers 62 under the heads and nuts thereof, are provided between end plates of the beam sections to in turn, provide tensioning means at the junctures. After the erection and assembly of the sections, spaces are left between the plates at the ends of the beam sections, and the bolts 61 are drawn to provide a proper tensioning. This tensioning results in tension in the inside of the knees of sections 52 and 53 and in the top of section 54, which is opposite to the effect of the load to be subsequently applied in the use of the structure. Abutment of the end plates 57 with plates 58 and 59 may be accomplished by accurate design and fabrication or by suitable shims.

In FIGURE 7 a modified form of juncture is shown which may be used between beam sections, such as in a frame of the type of FIGURE 6, where no intermediate columns or supports are used. Beam sections 52' and 54' are provided with offset plate sections 63 and 64, respectively. A horizontal portion of plate 63 provides a sliding support or base for a horizontal portion of plate 64 whereby beam section 54' may be temporarily supported. Bolts 65 between the upper vertical spaced portions of plates 63 and 64 provide means for connecting and tensioning the beam sections. Also, as in the other embodiments of the present invention, the lower vertical portions of the plates 63 and 64 are constructed and arranged such that these lower portions abut to leave a space between the upper portions whereby pretensioning may be accomplished in the upper portions of the beam sections.

In FIGURE 8 of the drawings there is shown a connection of a beam section 66 with an end support or column 67 where it may be desired to effect tensioning from both ends of an end beam of a series. Beam 66 is provided with a sloping plate 68 and column 67 is provided with a sloping cap plate 69. These plates are constructed or shaped such that in their welded attachment, or other connection, to the ends of the structural members there is abutment of the inside portions and gapping or spacing of the outer portions. Bolts 70 are provided at the outer portions of plates 68 and 69 to provide the desired tensioning in the top of beam 66. The beam 66 is held in alignment at the column 67 by supporting clip 71 and bolts 72.

In this latter embodiment, as well as with various of the other modifications, it is within the scope of the method of providing the desired pretensioning and camber to use adjustable tensioning means other than threaded bolts, as briefly set forth in connection with the description of FIGURE 2. The tensioning means may be of the nature of a C-clamp having adjustable threaded take-up means, or alternatively a hydraulically operated clamping means. Such means are used only temporarily during the tensioning step when it is desired to have fixed straps on the plates, such as plate 25 in FIGURE 2, so that it is not deemed necessary to illustrate such removable types of pulling or clamping means in the drawing.

I claim as my invention:

1. A multiple beam section system providing tension in the top portions thereof and resulting camber, which comprises in combination, at least two separate beam sections, means supporting and aligning the ends of adjacent beam sections one with another, means abuting the lower end portions of beam sections, separate individual support and anchoring means at the outer extremities of the outer beam sections of the multiple section system, an end plate attached to the abuting end of each beam and spaced apart upper portions of the ends of adjacent beam sections, and separate individually adjustable tensioning means connecting with and between said spaced upper portions of said sections whereby the tightening of last said means incorporates tension and camber in the top portions of said beam sections and ties said sections together in a continuous system.

2. A multiple beam system over a plurality of supports providing tension in the top flanges and resulting camber in the plurality of beams, which comprises in combination, a plurality of beam sections extending longitudinally in a multiple span arrangement, means supporting the bottom portions of each end of each beam and at each intermediate support, bearing means aligning and abuting the lower portions of adjacent beams, separate individual support and anchoring means at the outer ends of the terminal beams of the system

to the outside supports of the plurality thereof, an end plate attached to the abuting end of each beam and spaced apart upper portions of adjacent beams, and separate individually adjustable tensioning means connecting with and between said spaced upper portions of said adjacent beams, whereby the tightening of said tensioning means effects tension in top portions of the beams and camber therein and ties said beams together in a continuous system.

3. The beam system of claim 2 further characterized in that at each intermediate support the lower flanges of said beams abut one another and the upper end portions of said beams are spaced apart and are provided with opposing end sections which in turn have opposing holes adapted to have threaded bolts connecting therebetween, whereby said bolts may be tightened to provide tension along the top portions throughout the lengths of said beams.

4. The beam system of claim 2 further characterized in that fixedly attachable tie means are provided across the upper portions of adjacent beams in addition to said adjustable tensioning means.

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