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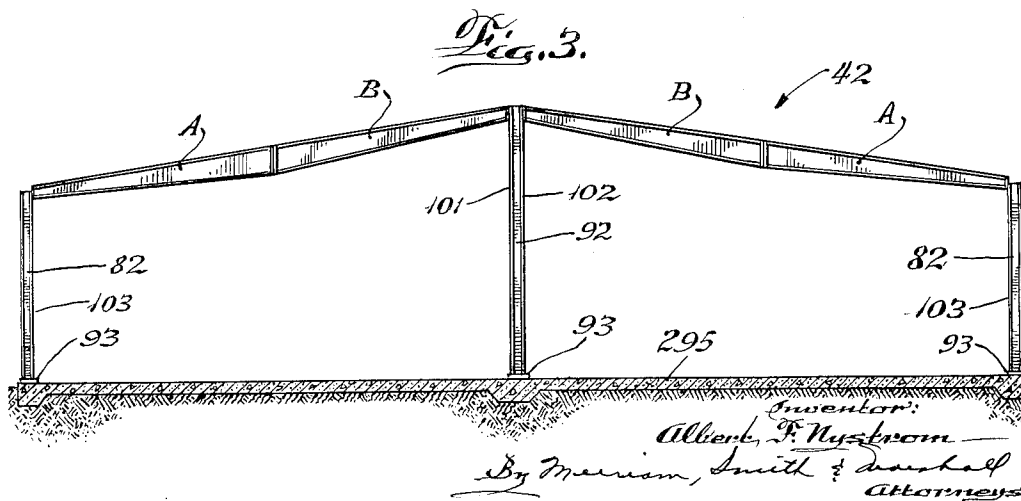
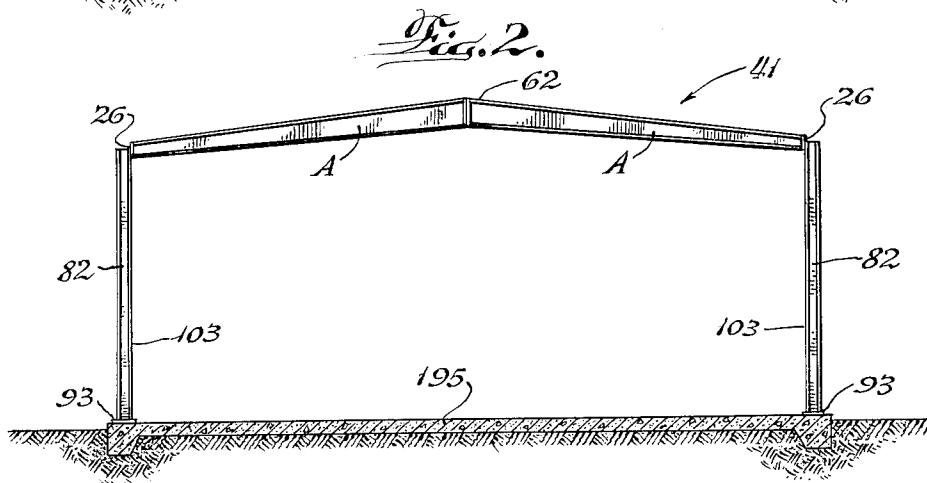
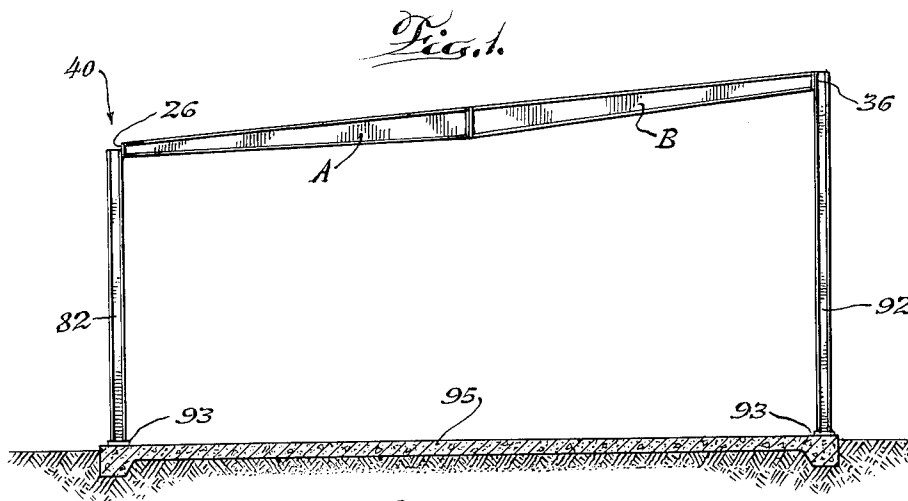
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3,224,151

ROOF BEAMS AND SUPPORTING COLUMNS

Filed June 26, 1962

3 Sheets-Sheet 1



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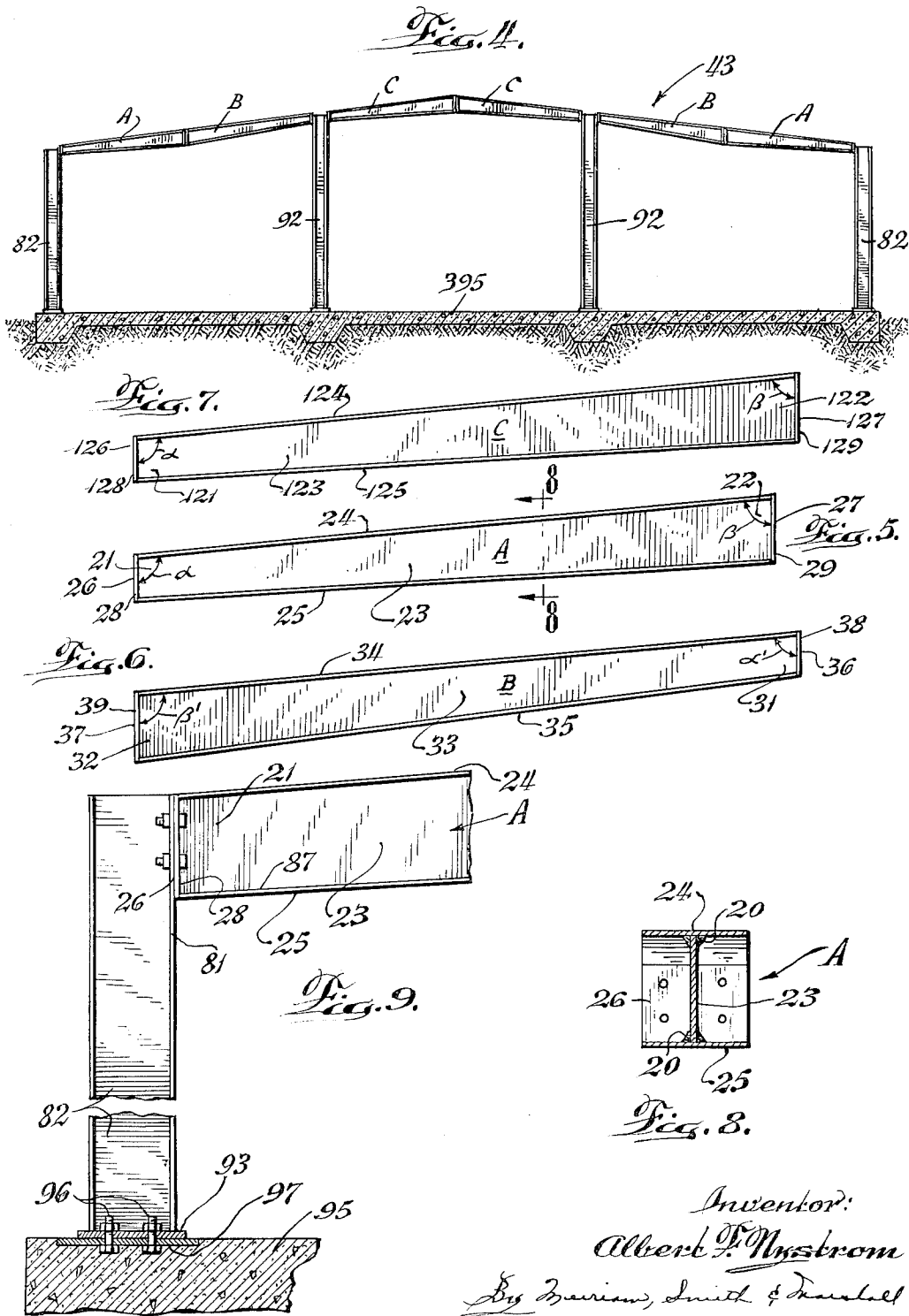
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5 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 10.

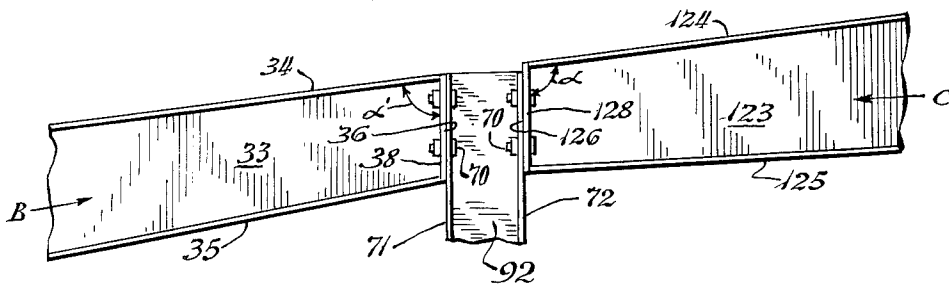
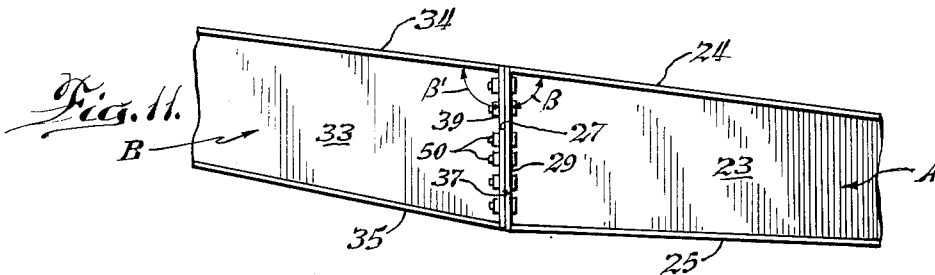
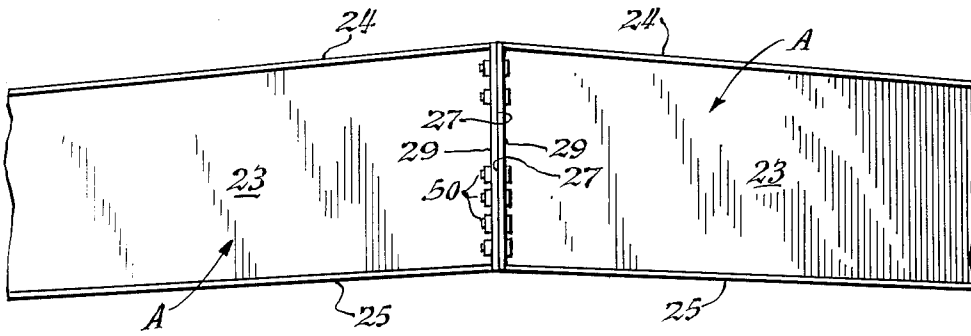


Fig. 12.

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1

3,224,151

ROOF BEAMS AND SUPPORTING COLUMNS

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2 Claims. (Cl. 52—90)

The present invention relates generally to roof beams for prefabricated metal buildings, and more particularly to a combination of three tapered beams which cooperate to produce a wide variety of modular roof sizes and shapes, each beam having a shape and relative size which simplifies roof construction and facilitates connection to the other beam and to other building members.

Each of the three beams, hereinafter referred to as A, B and C, has a longitudinally tapered shape, and includes a web and top and bottom flanges, the two flanges extending in diverging relation from a narrow or shallow end to a wide or deep end of the beam. Beams A and C are identical except that the length of beam C exceeds the length of beam A by one-half the width of a column used to support the beams, for reasons to be described in detail subsequently. The length of beam B equals the length of beam C.

The angle α , in the plane of the web of beams A and C, between the edge at the narrow end of these beams and the top flange thereof is equal to the angle β , in the plane of the web of beam B, between the edge at the wide end and the top flange thereof. Other important relationships among the top corner angles at both ends of the beams will be described subsequently. The bottom corner angles of the beams are not important from the standpoint of the instant invention, the slope of the beams' bottom flanges being determined by the strength requirements for the particular beam.

The wide end of each beam A is adapted to be connected in end-abutting relation to the wide end of the beam B. When the abutting edges at the wide ends of the two connected beams are vertically disposed the top flanges on both of the two end-abutting beams are inclined at the same angle corresponding to the desired roof slope or pitch. In addition, the edges at the narrow end of each connected beam are vertically disposed to facilitate connection to one side of a vertically disposed column, the other side of which may be connected to the vertically disposed narrow edge of a beam C the top flange of which then extends at the angle of slope of the roof. Accordingly, the three beams may be used together, in varying numbers and combinations in end-abutting relation with each other or with columns to provide various modular sizes of shed or gable roofs.

The connection between two abutting beams, at the wide ends thereof, is at a location where the moment in the roof support is a maximum, and the beams are designed so that the section depth at this point exceeds the requirements as determined by the beam moment curve.

Other features and advantages are inherent in the structure claimed and disclosed or will become apparent to those skilled in the art from the following detailed description in conjunction with the accompanying diagrammatic drawings wherein:

FIGURE 1 is a side elevational view illustrating a shed roof construction utilizing embodiments of beams A and B in accordance with the present invention;

2

FIGURE 2 is a side elevational view of a relatively narrow gable roof construction utilizing embodiments of beams A;

FIGURE 3 is a side elevational view of a wider gable roof construction utilizing embodiments of beams A and B in accordance with the present invention;

FIGURE 4 is an elevational view of a still wider gable roof construction utilizing embodiments of beams A, B and C in accordance with the present invention;

FIGURE 5 is a side elevational view of an embodiment of beam A in accordance with the present invention;

FIGURE 6 is a side elevational view of an embodiment of a beam B in accordance with the present invention;

FIGURE 7 is a side elevational view of an embodiment of a beam C in accordance with the present invention;

FIGURE 8 is a sectional view taken along line 8—8 in FIGURE 5;

FIGURE 9 is a fragmentary elevational view of a corner portion of a roof construction utilizing an embodiment of a beam A in accordance with the present invention;

FIGURE 10 is a fragmentary side view of the center portion of a gable roof construction utilizing an embodiment of beams A in accordance with the present invention;

FIGURE 11 is a fragmentary side view illustrating a connection between embodiments of beams A and B in accordance with the present invention; and

FIGURE 12 is a fragmentary side view of an intermediate connection in a roof utilizing embodiments of beams B and C in accordance with the present invention.

Referring initially to FIGURES 5 and 8, there is shown an embodiment of a first beam constructed in accordance with the present invention and indicated generally at A. Beam A includes narrow (shallow) and wide (deep) ends 21, 22 respectively, a web 23, and top and bottom flanges 24, 25 respectively welded to web 23 at weldments 20 (FIGURE 8). The flanges extend in upwardly inclined diverging relation from narrow end 21 to wide end 22. Located at ends 21, 22 respectively are end plates 28, 29. Beam A has vertical edges or sides 26, 27 defined by end plates 28, 29 at opposite ends 21, 22.

Referring now to FIGURE 6, there is illustrated an embodiment of a second beam constructed in accordance with the present invention, and indicated generally at B. Beam B may be used in conjunction with beam A in varying numbers and combinations to provide roof support structures in a variety of modular sizes and shapes. Beam B includes narrow (shallow) and wide (deep) ends 31, 32 respectively, web 33 and top and bottom flanges 34, 35 respectively; said top and bottom flanges extending in upwardly inclined converging relation from wide end 32 to narrow end 31. At ends 31, 32 are end plates 38, 39 respectively. Beam B has vertical edges or sides 36, 37 defined by end plates 38, 39 at opposite ends 31, 32 respectively.

FIGURE 7 illustrates an embodiment of a third beam C, constructed in accordance with the present invention, and comprising narrow (shallow) and wide (deep) ends 121, 122 respectively, a web 123, and top and bottom flanges 124, 125 respectively. The flanges extend in upwardly inclined diverging relation from narrow end 121 to wide end 122; and located at ends 121, 122 respectively are end plates 128, 129. Beam C has vertical edges or

sides 126, 127 defined by end plates 128, 129 at opposite ends 121, 122.

Both beams A and C have top corner angles α and β between the top flange and the narrow and wide edges thereof respectively. Beam B has corresponding top corner angles α' and β' . The following important angular relationships exist.

$$\begin{aligned}\alpha &= \beta' \\ \beta &= \alpha' \\ \beta + \beta' &= 180^\circ \\ \alpha - 90^\circ &= \text{slope of roof} \\ 90^\circ - \beta &= \text{slope of roof} \\ \beta' - 90^\circ &= \text{slope of roof} \\ 90^\circ - \alpha' &= \text{slope of roof}\end{aligned}$$

Some typical roof structures, constructed from combinations of beams A, B and C, of varying modular sizes and shapes, are illustrated in FIGURES 1 through 4. FIGURE 1 illustrates a shed roof composed of beams A and B joined together at their wide ends and supported at their narrow ends by columns 82, 92 extending upwardly from base members 93 on a foundation slab 95.

FIGURE 2 illustrates a gable roof structure composed of a pair of beams A joined together at their wide ends and having their narrow ends supported by vertically disposed columns 82 on a foundation slab 95.

FIGURE 3 illustrates a gable roof structure twice as wide as the gable roof illustrated in FIGURE 2. The roof structure of FIGURE 3 includes a pair of beams A and a pair of beams B. A beam A and a beam B from each pair are joined together at their wide ends. The narrow end of each beam A is supported by a respective vertically disposed column 82; and the narrow ends of both beams B are both connected at the center of the roof structure to a single vertically disposed central column 92. All the columns are on a foundation slab 95.

It should be emphasized that beam B exceeds beam A in length by one-half the width of a column such as 82. (As used herein, the term "length" means the length of the projection of a beam or roof on a horizontal plane.) This is to assure a building and roof width, from the outside vertical surface of column 82 on the left in FIGURE 3 to the outside vertical surface of column 82 on the right in FIGURE 3, twice that of the embodiment illustrated in FIGURE 2.

More specifically, if two structures such as that illustrated in FIGURE 2 were placed side by side, the combined width would equal two times the distance between the edge 26 on a left-hand beam A and the edge 26 on a righthand beam A plus the width of four columns 82. In the embodiment of FIGURE 3 there are only three columns. Accordingly, the width of the absent column is compensated by providing each of the two beams B with a length equal to that of beam A plus one-half a column width. If beams B were only the same length as beam A, there would be a gap between a narrow end of a beam and a column. This is because the opposite vertical surfaces 101, 102 of central column 92 are spaced from a respective outer column 82, a distance exceeding the distance between the inner surfaces 103 of columns 82 in FIGURE 2 by one-half a column width.

FIGURE 4 illustrates a gable roof construction three times as wide as the roof of FIGURE 2 and composed of a pair of beams A, of beams B and of beams C. Each beam B is connected at its wide end to a respective beam A having its narrow end supported by a respective vertically disposed end column 82. The narrow end of each beam B is connected to a respective vertically disposed inner column 92. Also connected to each column 92 is the narrow end of a respective one of an inner pair of beams C having their wider ends connected together at the center of the roof structure.

The length of a beam C is the same as the length of a beam B, that is—one-half a column width longer than

beam A. The extra one-half column length of each beam B and C compensates for the gap which would otherwise exist in the embodiment of FIGURE 4 between the narrow ends of the beams and the columns due to the embodiment of FIGURE 4 having only four columns compared to the six columns which would be present if three of the embodiments of FIGURE 2 were placed side by side to produce a building of the same width as that of FIGURE 4.

Thus the three beams A, B and C enable the construction of buildings in modular sections having a width of X, 2X, 3X, etc. with a minimum number of columns. Furthermore, the beams utilized in constructing a building of X width can be used in constructing a building of 2X width and the beams used for the latter can also be used in a building of 3X width. This reduces the number and variety of beams which must be made and stockpiled in order to produce a variety of building widths thus reducing the cost to both the manufacturer and the purchaser.

The connection between beams A and B in the roof structure illustrated in FIGURE 1 is shown in greater detail in FIGURE 11. Beams A, B are connected together at their wide end edges 27, 37 respectively by means such as bolts 50 (or other fasteners of a strength suitable to resist the applied moment) extending through end plates 29, 39 on beams A, B respectively; and edges 27, 37 are vertically disposed. As thus connected, and because of the previously described relationships among the top corner angles α , β and α' , β' of beams A, B respectively, the top flanges 24, 34 on beams A, B extend upwardly at the same angle equal to the desired slope of the roof; and narrow end edges 26, 36 are vertically disposed (FIGURE 1).

It should be noted that the shed roof structure of FIGURE 1 could not be produced by using two beams A, or a beam A and a beam C with their wide ends in abutting relation. This is because the top corner angle α on these beams is not the same as the other top corner angle β . On the other hand, the top corner angle β' on beam B does equal the top corner angle α on beams A and C.

The connection of the two beams at their wide ends is at a location where the moment in the roof-supporting structure is a maximum, but it is not critical because the depth of the webs at this location is in excess of that required to resist the moment.

The connection of the wide ends of beams A and B in the roof structures of FIGURES 3 and 4 are identical to the connections between the wide ends of these two beams in the shed roof structure of FIGURE 1, illustrated in enlarged detail in FIGURE 11.

The connection between the two beams A in the gable roof illustrated in FIGURE 2 is shown in greater detail in FIGURE 10. Beams A are connected together at their edges 27 by bolts 50 extending between end plates 29. Abutting edges 27 are vertically disposed. Accordingly, flanges 24 slope at the desired angle and edges 26 are vertical (FIGURE 2).

The connection of beams B, C to vertically disposed center columns 92 in the roof structure illustrated in FIGURE 4 is shown in greater detail in FIGURE 12. In this structure two sets of beams A and B are connected together as shown in FIGURE 11; and a pair of beams C are connected like beams A in FIGURE 10. Accordingly, edges 126, 36 are vertically disposed to facilitate connection to vertical column 92. More specifically, vertical edge 126 of beam C is connected in abutting relation to a flange 72 on column 92 by bolts 70 extending through flange 72 and end plate 128 on beam C. Vertical edge 36 on beam B is connected in abutting relation to a flange 71 on beam 92 by rivets 70 extending through flange 71 and end plate 38 on beam B. Because of the previously described relationships among the top corner angles of beams B and C, the respective top flanges there-

5

of, 34 and 124, extend upwardly at the same slope equal to the desired roof pitch.

The connection of the narrow end of beam A to vertically disposed outer column 82, in the roof structures of FIGURES 1 through 4, is illustrated in detail in FIGURE 9. The vertical edge 26 of beam A is connected in abutting relation to an inner flange 81 on column 82 by bolts 80 extending through end plate 28 and flange 81. Column 82 extends upwardly from a base member 93 connected by bolts 96 to a member 97 embedded in foundation slab 95.

There have thus been described a combination of beams A, B, C utilizable in various combinations to produce a variety of modular roof structures of varying sizes and shapes, it being understood that the roof structures of FIGURES 1 through 4 may also be used in a single building in combination with other shed or gable roof portions having width other than a multiple of the width of the roof in FIGURE 2.

In each embodiment of roof structure, the two edges of each beam A, B, C are vertically disposed; and each vertical edge extends from the top flange to the bottom flange of the beam. The wide end vertical edge or side of each beam is in coextensive abutting relation with the wide end vertical edge or side of another beam; and the narrow end vertical edge or side of each beam is in abutting relation with the adjacent vertical flange of a supporting column. Each beam A, B, C has a polygonal configuration consisting of four sides defined by the two vertical edges or sides of the beam, the top flange of the beam and the bottom flange of the beam.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. In a building;

a pair of beams consisting of first and second roof beams;

each of said beams having a deep end and a shallow end;

each beam having a web and top and bottom inclined flanges each extending in a continuous, unchanging slope between said ends;

each beam having a vertical side at each end thereof;

each of said vertical sides extending from the top inclined flange to the bottom inclined flange of the beam;

said vertical sides at the deep ends of the two beams being in mutually abutting relation, with the deep end vertical side on each of said beams having the same depth as and being coextensive with the deep end vertical side on the other of said beams;

a plurality of supporting columns each having vertically disposed surfaces;

said top and bottom flanges on said first beam extending in upward inclined diverging relation from the vertical side at the shallow end to the vertical side at the deep end;

said top and bottom flanges on said second beam extending in upward, inclined, converging relation from the vertical side at the deep end to the vertical side at the shallow end;

a respective vertical side at said shallow end of each of said pair of beams being abuttingly engaged to a vertically disposed surface on a respective one of a pair of said supporting columns;

said top flange of one of said beams being inclined at the same angle as, and constituting a continuation of, the top flange of the other of said beams;

the bottom flanges on said first and second beams extending from a mutual junction at the deep ends of the beams to define a single angle between said pair of supporting columns;

each of said columns having the same width;

6

the length of said second beam being equal to the length of said first beam plus one-half the width of a column, so that a second pair of roof beams identical to said first-recited pair and a supporting column identical to one of said first-recited supporting columns may be symmetrically arranged with the webs of said second pair in coplanar opposition to the webs of said first-recited pair and thereby provide a building of modular construction utilizing a minimum number of different types of beams and columns.

2. In a building;

a pair of outer columns each having vertically disposed surfaces;

a pair of inner columns each having vertically disposed surfaces;

a first pair of first and second beams;

a second pair of first and second beams;

a pair of third beams;

each of said beams having a deep end, and a shallow end;

each beam having a vertical side at each end thereof, each beam having a web and top and bottom inclined flanges each extending in a continuous unchanging slope between said ends;

the top and bottom flanges on each first and third beam extending in upward, inclined, diverging relation from the vertical side of the shallow end to the vertical side at the deep end;

the top and bottom flanges on each second beam extending in upward inclined converging relation from the vertical side at the deep end to the vertical side at the shallow end;

said vertical sides at the deep ends of the beams in all of said pairs being connected in mutually abutting relation, with the deep end vertical side on each of said beams having the same depth as and being coextensive with the deep end vertical side on the other of said beams;

each deep end vertical side extending from the top inclined flange to the bottom inclined flange of the beam;

the shallow end vertical sides on said first beams of the first and second pairs being connected in abutting relation to a vertically disposed surface on a respective outer column;

the shallow end vertical sides on said second beam of the first and second pairs being connected in abutting relation to a vertically disposed surface on a respective inner column;

the shallow end vertical sides on each of said third beams being connected in abutting relation to a vertically disposed surface on a respective inner column, opposite the surface connection of said column to said second beam;

the top flanges on the second beam of each of the first and second pairs extending upwardly at the same angle as, and constituting a continuation of, the top flange of the first beam of the same pair of beams; the bottom flanges on said first and second beams of the same pair of beams extending from a mutual junction at the deep ends of the beams to define a single angle between the pair of columns to which said beams are abuttingly connected;

the top flange on a respective one of said third beams extending upwardly at the same angle as and constituting a continuation of the top flange on the closest second beam of the first and second pair of beams;

all of said columns having the same width;

the length of said second beam being equal to the length of said first beam plus one-half the width of a column;

and the length of a third beam being equal to the length of said second beam, to provide a building of

modular construction utilizing a minimum number
of different types of beams and columns.

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