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(54) ASSEMBLED ROOF STRUCTURE OF METAL MEMBERS

(71) We, YOSHIDA KOGYO K.K., a Japanese body corporate of 1 Kanda Izumicho Chyoda-Ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to an assembled roof structure including metal rafters and a metal rafter support, e.g. for a terrace, or a balcony or the like.

15 In a roof structure for a terrace, balcony or the like, rafters are placed on a horizontal rafter support, as well as on a horizontal cross-beam which is positioned below, and at a given distance from the rafter support, in a manner so as to span the two members. Accordingly, the inclination of a roof to be constructed is dependent on the inclination of the rafters, whilst the inclination of the rafters is defined by the relative positions of the beam and the rafter support.

25 According to the present invention, there is provided an assembled roof structure comprising: a first metal member forming a horizontal rafter support or cross-beam or purlin and having a channel portion; a second metal member forming a rafter; and a joint member coupling said first metal member to said second metal member, said channel portion having an inner surface which is part-circular in cross-section, said channel portion having an opening out-
 35 wardly of the first metal member, the width of the opening being less than half the diameter of said inner surface, and said joint member having an engaging portion engaged in said channel portion of said first metal member and a base portion secured to said second metal member, the relative angular positions of said channel portion and said joint member preventing disengagement thereof.

45 The invention will be described by way of examples with reference to the accompanying drawings which illustrate embodiments of the invention, and in which:

50 Figure 1a is a cross-sectional view repre-

senting a roof structure embodying the present invention;

Figure 1b is a lateral cross-sectional view of a rafter shown in Figure 1a;

Figure 2 is a view of part of the structure of Figure 1 illustrative of the attaching operation of a joint member to a rafter support or to a cross-beam;

Figures 3 to 6 are cross-sectional views of other embodiments of the present invention;

Figure 7 is a view similar to Figure 1a, which shows a further embodiment of the invention;

Figure 8 is a cross-sectional view of a rafter of Figure 7;

Figure 9 and Figure 10 are views similar to Figure 8 which show further forms of rafters; and

Figures 11 and 12 are cross-sectional views showing further forms of purlins.

Referring now to Figure 1a, a horizontal rafter support 2 is secured to a side wall of a structure 1, whilst at least two posts 3 are positioned upright at a given distance from the structure 1. A cross-beam 4 is placed on top of the posts substantially in parallel relation to the rafter support 2.

The rafter support 2 is of metal having a generally rectangular cross section, including flange portions 2a to be secured to the structure 1, and is formed with upper and lower channel portions 5, 5 extending along the length of the support 2.

The channel portions 5, 5 have inner surfaces of a part-circular cross section as viewed in the longitudinal direction of the rafters, and each channel portion has an opening outwardly of the rafter support 2. The width of the opening is less than half the internal diameter of the channel portion 5. The upper and lower inside corner edges of the rafter support 2 are rounded.

The rafter support 2 should afford a desired strength so as to bear a given load. The rafter support 2 may be placed either way up, being symmetrically formed.

A cross beam 4 is of metal with a generally rectangular cross-section, and formed with upper channel portions 6, 6 on the

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opposite side-walls thereof, which portions extend along the length of the beam 4.

The channel portions 6, 6 have inner surfaces of a part-circular cross section like the channel portions 5, 5, and the channel portions are open outwardly of the beam. In this respect, the width of the opening is less than half the internal diameter of the channel portion 6. The upper, inside and outside corner edges of the beam 4 are rounded similarly to the two rounded edges of the rafter support 2. The channel portions 6 which are positioned inwardly of the rafter support 2 may be dispensed with, if desired.

Lipped channels 7, 7 are provided inwardly of a bottom wall of the beam 4, with a given spacing between them, for fastening the bottom wall of the beam 4 to the top surface of a post 3. Heads of bolts 8, 8 are loosely fitted in the channels 7, 7 and retained therein by the lips of the channels, for fastening the beam 4 to the post 3, and the heads of bolts 8, 8 may slide along the length of the beam 4, as required, until nuts 8 are tightened.

The beam 4 is secured to the top surface of the post 3 by means of the bolts 8 and the nuts 8¹ through the medium of a coupling plate 3a which is secured to the post 3 by means of screws.

Rafters 9 are placed on the rafter support 2 as well as on the beam 4 in a manner so as to span the two members.

The rafter 9 is a metal member with a generally rectangular cross-section, as shown in Figure 1b, whilst lipped channels 14, 15 are provided inwardly of the upper and lower walls of the rafter 9, and open outwardly of the rafter 9 and extend along the length thereof. Each rafter 9 is fastened to the rafter support 2 and beam 4 through the medium of a respective pair of joint members 10, 10.

Each joint member 10 includes an engaging portion 10b which is contiguous with one edge of a base portion 10a. The engaging portion 10b has a convex outer surface of a part-circular shape, which is complementary to the shape of concave channel portion 5, 6. The engaging portions 10b, 10b of each pair of joint members 10 are fitted in the channel portions 5, 6, respectively, and thus the joint members 10, 10 may be moved pivotally relative to the beam 4 and rafter support 2, respectively, before the base portions 10a, 10a are secured to the undersurface of the rafter by means of bolts 16, 16 and nuts 16¹, 16¹ threaded thereon, with the heads of bolts 16, 16 loosely fitted in the lipped channel 15.

Several purlins 11 are placed on the rafters 9 at a right angle thereto at a given spacing.

Each purlin 11 is a metal member with a

generally rectangular shape in cross-section, and formed with lower channel portions 12, 12 on the opposite side-walls inwardly thereof in a manner to extend along the length of the purlin 11. The channel portions 12, 12 each have a concave, inner surface of a part-circular cross-section like the channel portions 5, 6, and each has an opening outwardly of the purlin 11, the width of the opening being less than half the internal diameter of each of the channel portions 12, 12. Each purlin 11 is secured to each rafter 9 through the medium of a respective pair of joint members 10, 10 similar to those fastening the rafter 9 to the rafter support 2 and beam 4.

Engaging portions 10b, 10b of the joint members 10, 10 are fitted in the channel portions 12, 12 on the purlin 11, respectively, while base portions 10a, 10a are secured to the top surface of the rafter 9 by means of bolts 17, 17 and nuts 17¹, 17¹ threaded thereon, with heads of bolts 17, 17 loosely fitted in the lipped channel 14.

A purlin 11¹ as shown in Figure 1a may be used in place of purlin 11. In this case, for securing the purlin 11¹ to the rafter 9, a joint member 10¹ is used, which includes an engaging portion 10¹b (of a shape complementary to the shape of an engaging portion 12¹) and base portion 10¹a.

Roof members 13 are placed on top of the purlins 11, and secured by means for example of hook bolts 18.

For assembly of the structure thus arranged, the rafter support 2 is secured to a side wall of the structure 1 at a given level, while the beam 4 is secured to the top surface of the post 3 at a given level, respectively.

Then, rafters 9 are placed on the top surfaces of rafter support 2 and beam 4 in a manner to span the two members 2, 4. Thereafter, the rafters 9 are each coupled to the rafter support 2 and beam 4, respectively.

In this respect, the base portions 10a, 10a of the joint members 10, 10 are held parallel with the inner surface of rafter support 2 as well as with the side surface of the beam 4, and then the engaging portions 10b, 10b are inserted through the slits into the channel portions 5, 6, respectively. Then, the base portions 10a, 10a of the joint members 10, 10 are raised to the positions shown in dotted lines in Figure 2. This ensures the positive engagement of engaging portions 10b, 10b with the channel portions 5, 6 and, accordingly, the engaging portions 10b, 10b will not become detached from the channel portions 5, 6. Then, the base portions 10a, 10a are secured to the undersurface of the rafter 9.

The purlins 11 are placed on the rafters 9, and secured to the rafters 9 by means of

joint members 10, 10, after which the roof members 13 are placed on the purlins 11.

With the aforesaid roof structure, the first metal member (rafter support 2, cross-beam 4, or purlin 11) may be coupled to the second metal member (rafter 9) with ease positively.

In addition, the second metal member may be moved to a desired position along the channel portion on the first metal member, as required. In this case, any excessive length of the first metal member can be cut off.

Furthermore, the first metal member (rafter support 2, or cross-beam 4) may be pivotally moved relative to the second metal member (rafter 9) through the medium of the joint members 10, 10 in terms of the positional relationship between the two members alone. Accordingly, roof structures including rafters 9 having varying inclinations, i.e., roof structures of varying inclinations may be constructed without modifying the metal members. This avoids any need to modify the rafter supports and other associated parts.

Figures 3 to 6 show further embodiments of the invention. Figure 3 shows an example of a modified rafter support 2¹ having channel portions 2^{1a} extending along the length of the support 2 at its root portions, in place of the rafter support 2.

With the above arrangement, rain water which may enter through a clearance between the end of the roof member and the side wall of the structure 1 may be drained effectively.

Figures 4 to 6 show examples of modified rafter supports 2¹¹ of a generally 'L' shaped cross-section, each of which is formed with a channel portion 5¹ positioned at one edge thereof in a manner to extend along the length of the rafter support 2¹¹, in place of the rafter support 2.

The above arrangement may save the cost of materials and Figures 5 and 6 show modified rafter supports having built-up or upset portions on their top surfaces at their tips, thereby forming channel portions 2^{11a}, 2^{11a} between the roofs and the channel portions 5¹, 5¹, respectively. This allows any rain water to be drained along the channels 2^{11a}, which water has entered through the clearance between the end of a roof member and the side wall of the structure 1.

Figures 7 to 12 show further embodiments of the present invention. Like parts in Figures 7 to 12 are designated by like reference numerals as those given in Figures 1 to 6.

The rafter support 112¹¹ shown in Figure 7 is a metal member of a generally L-shaped cross-section, similar to that given in Figure 4, with a channel portion 5¹ along one edge, the channel portion 5¹ extending along the

length of rafter support 112¹¹ and opening outwardly thereof. The inner upper edge of the rafter support 112¹¹, which abuts the rafter 119, is rounded.

Each rafter 119 is a metal member with a generally rectangular cross-section, as shown in Figure 8, lipped channels 14, 15 being provided inwardly of top and bottom walls respectively of the rafter 119 in the centre thereof, in the same manner as in Figure 1b, whilst channel portions 112, 112 are provided inwardly of the opposite side walls in a manner to extend along the length of rafter 119. The channel portions 112, 112 are similar to the channel portions 5, 5¹, 6. The rafters 119 are coupled to the rafter support 112¹¹ through the medium of joint members 10, 10 in the same manner as in the preceding embodiment. A rafter 119¹ having a smaller width may be used in place of the rafter 119, as shown in Figure 9. Furthermore, a rafter 119¹¹ having four channel portions 112, 112 provided inwardly of the side walls, two at the top and two at the bottom, as shown in Figure 10, may be used in place of the rafter 119.

Such a rafter 119¹ may be lighter in weight than rafter 119, whilst the use of the rafter 119¹¹ allows the mounting of the rafter 119¹¹ up side down, on the rafter support 112¹¹ and beam 4, upon assembly.

Purlins 111, each made of metal with a generally rectangular cross-section, are placed on top of the rafters 119 at a right angle to the rafters 119, as shown in Figures 7 and 8. The surface (of the purlin 111) which contacts the rafter 119 is formed with a lipped channel 19 extending along the length of the purlin 111, with the head of a bolt 17 being loosely fitted therein. The base portion 10a of the joint member 10 may be secured to the purlin 111 by means of a bolt 18, with the engaging portion 10b thereof being fitted in and engaging the channel portion 112 in the rafter 119, as shown in phantom in Figure 8.

Meanwhile, metal purlins a, b, c, d, e, f, or g having varying cross-sectional shapes may be used in place of the purlin 111, as shown in Figures 7, 11, and 12, respectively.

The use of purlin a of small width may save the cost of materials and weight of purlins. In addition, the use of purlin b having lipped channels 19¹, 19¹ allows the purlin b to be used in a different position from that shown, namely, with the two side walls having the channels 19¹, 19¹ respectively in contact with the rafter 119 and the roof members 13, for changing the level of the roof members 13.

The purlin c, which is formed with a lipped channel 19 offset to one side as shown, allows the purlin to be used either as shown or turned round to put the channel

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19 on the left for adjusting the position of the purlin.

The purlins *d, e, f* of a generally 'H' shaped cross-section, or purlin *g* of a generally 'U' shaped cross-section, allow the use of shorter hook bolts 18¹ as shown in Figures 11 and 12 for securing the roof member 13 to the purlins 9. This contributes to the saving in cost of materials.

As is apparent from the foregoing, the first and second metal members may be coupled to each other positively with ease in a manner that an angle of the first metal member relative to the second metal member may be adjusted.

Accordingly, a roof structure embodying the present invention as described above allows shifting of the rafters, purlins and the like to desired positions, as required.

In addition, the rafter support or beam and rafter may be pivotally coupled through the medium of the joint members of the aforesaid arrangement, so various roof structures including beams and rafter supports having different relative positions for each roof structure may be constructed by using a single type of rafter supports, beams, joint members and the like, respectively.

The relative angular positions of said channel portions 5, 6, 12 on the one hand and respective joint members 10 on the other hand prevent disengagement thereof.

WHAT WE CLAIM IS:—

1. An assembled roof structure comprising: a first metal member forming a horizontal rafter support or cross-beam or purlin and having a channel portion; a second metal member forming a rafter; and a joint member coupling said first metal member to said second metal member, said channel portion having an inner surface which is part-circular in cross-section, said channel portion having an opening outwardly of the first metal member, the width of the opening being less than half the diameter of said inner surface, and said joint member having an engaging portion engaged in said channel portion of said first metal member and a base portion secured to said second metal member, the relative angular positions of said channel portion and said joint member preventing disengagement thereof.

2. An assembled roof structure as claimed in Claim 1, wherein said first metal member having said channel portion is a rafter support an end portion of said rafter

support being formed with said channel portion.

3. An assembled roof structure as claimed in Claim 1, wherein said first metal member having said channel portion is a cross-beam and wherein an outer, top edge portion of said beam is formed with said channel portion.

4. An assembled roof structure of metal sections as claimed in any one of Claims 1 to 3, wherein said second metal member is of a rectangular cross section, and is formed with at least one channel inwardly of one wall thereof, which channel extends along the length of said second metal section, and wherein said second and first metal members are coupled together through the medium of said joint member by means of bolts and nuts threaded thereon, said bolts extending through the base portion of said joint member.

5. An assembled roof structure as claimed in any one of Claims 1 to 3, wherein said channel portion extends from one end of said first metal member to the other along the length of said first metal member.

6. An assembled roof structure as claimed in Claim 1, 2, 3 or 5, wherein said first metal member is of a generally rectangular cross-section, with a channel formed in and along a corner portion of said first metal member.

7. An assembled roof structure as claimed in Claim 1, 2, 3, or 5, wherein said first metal member is of a 'L' shaped cross-section, and has said channel portion along one side edge thereof.

8. An assembled structure as claimed in Claim 2, wherein a portion or edge of said rafter support, which portion or edge contacts said rafter, is rounded.

9. An assembled roof structure as claimed in Claim 3, wherein such a portion or edge of said beam, which portion or edge contacts said rafter, is rounded.

10. An assembled roof structure as claimed in Claim 3, 8 or 9, wherein said rafter is of a generally rectangular cross-section, and has a top wall and a bottom wall which are both formed with channels extending from one end to the other along the length of said rafter.

11. An assembled roof structure substantially as described with reference to and as illustrated in any one of Figures 1 to 12 of the accompanying drawings.

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19 on the left for adjusting the position of the purlin.

The purlins *d, e, f* of a generally 'H' shaped cross-section, or purlin *g* of a generally 'U' shaped cross-section, allow the use of shorter hook bolts 18¹ as shown in Figures 11 and 12 for securing the roof member 13 to the purlins 9. This contributes to the saving in cost of materials.

As is apparent from the foregoing, the first and second metal members may be coupled to each other positively with ease in a manner that an angle of the first metal member relative to the second metal member may be adjusted.

Accordingly, a roof structure embodying the present invention as described above allows shifting of the rafters, purlins and the like to desired positions, as required.

In addition, the rafter support or beam and rafter may be pivotally coupled through the medium of the joint members of the aforesaid arrangement, so various roof structures including beams and rafter supports having different relative positions for each roof structure may be constructed by using a single type of rafter supports, beams, joint members and the like, respectively.

The relative angular positions of said channel portions 5, 6, 12 on the one hand and respective joint members 10 on the other hand prevent disengagement thereof.

WHAT WE CLAIM IS:—

1. An assembled roof structure comprising: a first metal member forming a horizontal rafter support or cross-beam or purlin and having a channel portion; and a second metal member forming a rafter; and a joint member coupling said first metal member to said second metal member, said channel portion having an inner surface which is part-circular in cross-section, said channel portion having an opening outwardly of the first metal member, the width of the opening being less than half the diameter of said inner surface; and said joint member having an engaging portion engaged in said channel portion of said first metal member and a base portion secured to said second metal member, the relative angular positions of said channel portion and said joint member preventing disengagement thereof.

2. An assembled roof structure as claimed in Claim 1, wherein said first metal member having said channel portion is a rafter support an end portion of said rafter

support being formed with said channel portion.

3. An assembled roof structure as claimed in Claim 1, wherein said first metal member having said channel portion is a cross-beam and wherein an outer, top edge portion of said beam is formed with said channel portion.

4. An assembled roof structure of metal sections as claimed in any one of Claims 1 to 3, wherein said second metal member is of a rectangular cross section, and is formed with at least one channel inwardly of one wall thereof, which channel extends along the length of said second metal section, and wherein said second and first metal members are coupled together through the medium of said joint member by means of bolts and nuts threaded thereon, said bolts extending through the base portion of said joint member.

5. An assembled roof structure as claimed in any one of Claims 1 to 3, wherein said channel portion extends from one end of said first metal member to the other along the length of said first metal member.

6. An assembled roof structure as claimed in Claim 1, 2, 3 or 5, wherein said first metal member is of a generally rectangular cross-section, with a channel formed in and along a corner portion of said first metal member.

7. An assembled roof structure as claimed in Claim 1, 2, 3, or 5, wherein said first metal member is of a 'L' shaped cross-section, and has said channel portion along one side edge thereof.

8. An assembled structure as claimed in Claim 2, wherein a portion or edge of said rafter support, which portion or edge contacts said rafter, is rounded.

9. An assembled roof structure as claimed in Claim 3, wherein such a portion or edge of said beam, which portion or edge contacts said rafter, is rounded.

10. An assembled roof structure as claimed in Claim 3, 8 or 9, wherein said rafter is of a generally rectangular cross-section, and has a top wall and a bottom wall which are both formed with channels extending from one end to the other along the length of said rafter.

11. An assembled roof structure substantially as described with reference to and as illustrated in any one of Figures 1 to 12 of the accompanying drawings.

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