

[54] METAL ROOF

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[51] Int. Cl.² E04D 1/00

[58] Field of Search 52/518, 519, 520, 528,
52/539, 542, 545, 492, 593, 478, 483, 588

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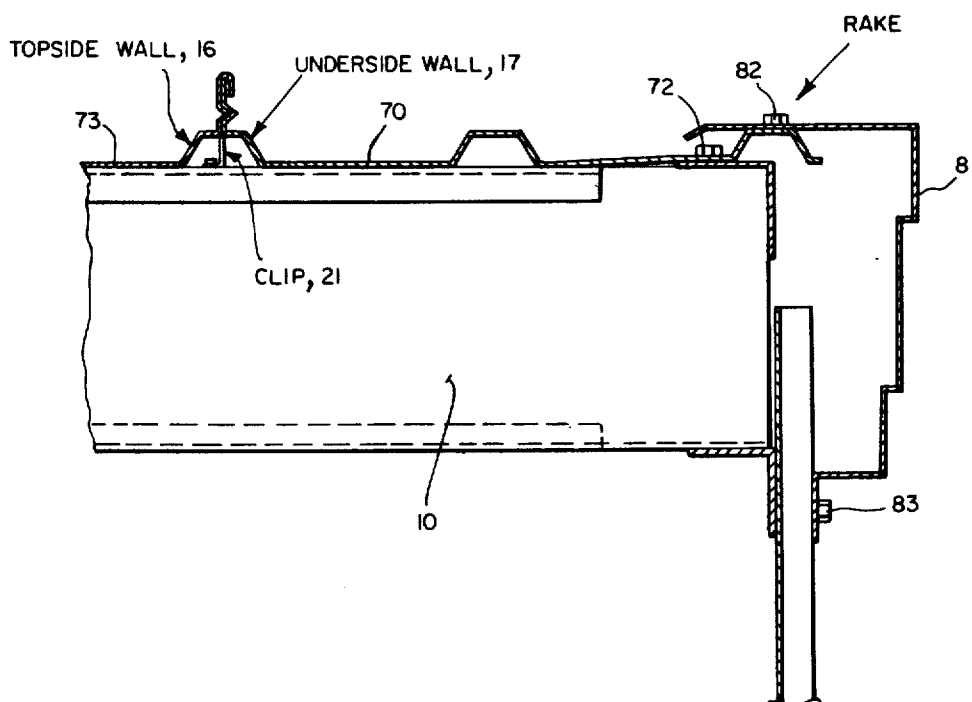
Primary Examiner—John E. Murtagh

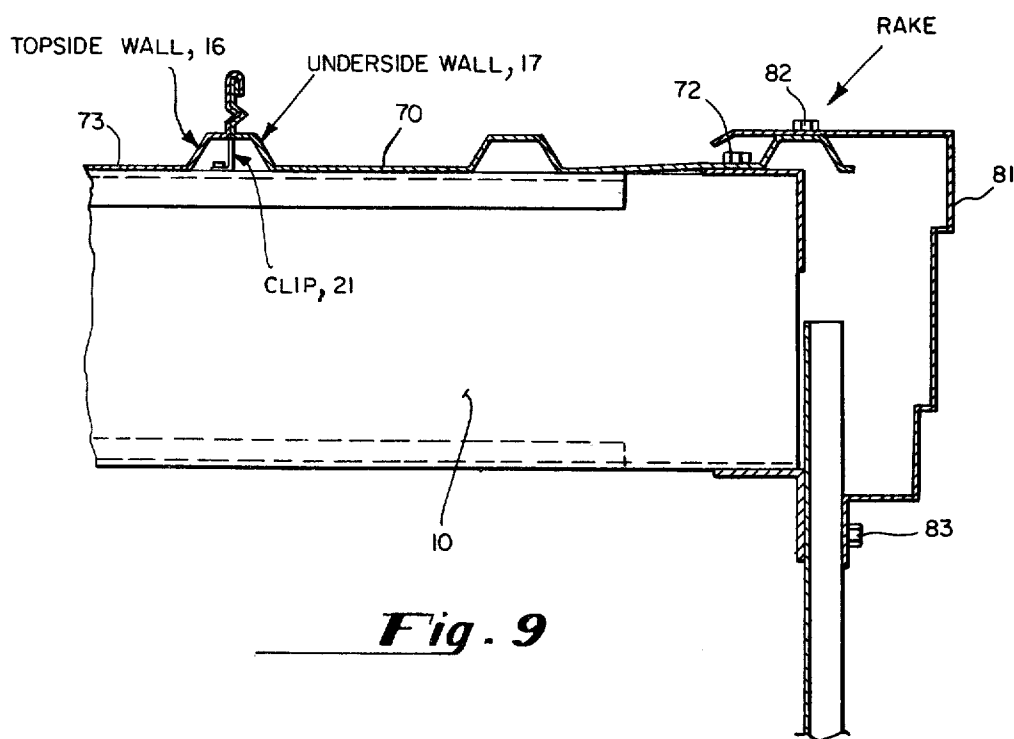
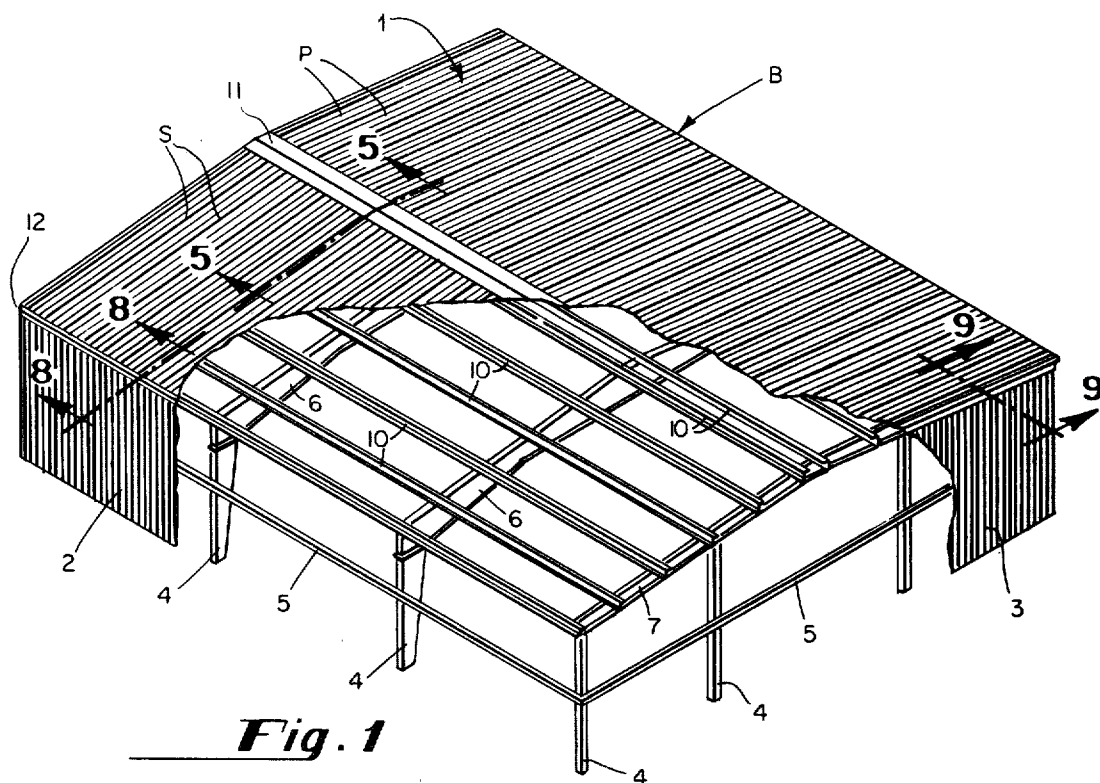
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[57] **ABSTRACT**

A standing seam roof comprising seamed-edge panels held down on the roof supporting structure by clips which have V-shaped sections interfitting with V-shaped sections on the panels. The clips are concealed in the seam.

10 Claims, 11 Drawing Figures





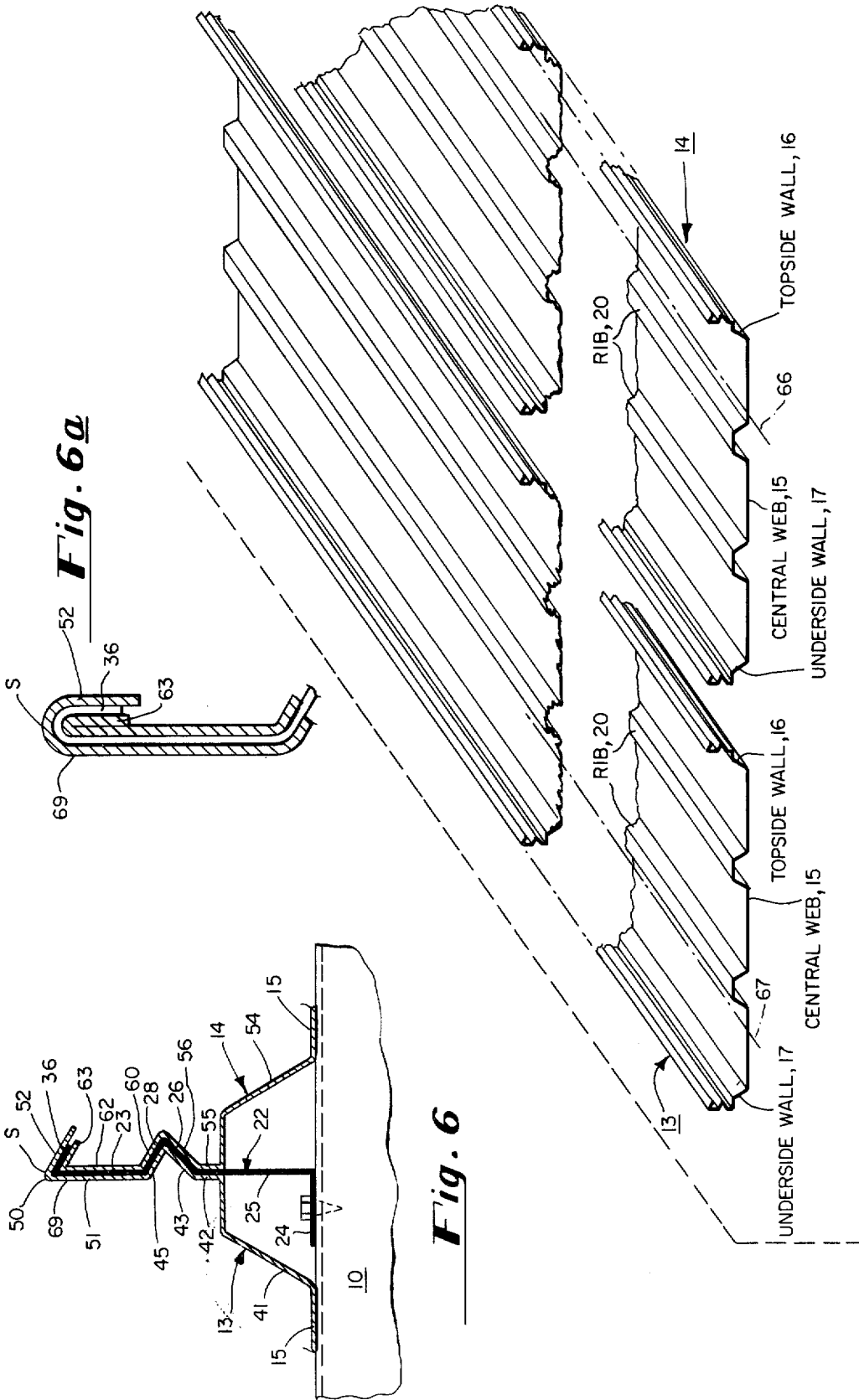


Fig. 2

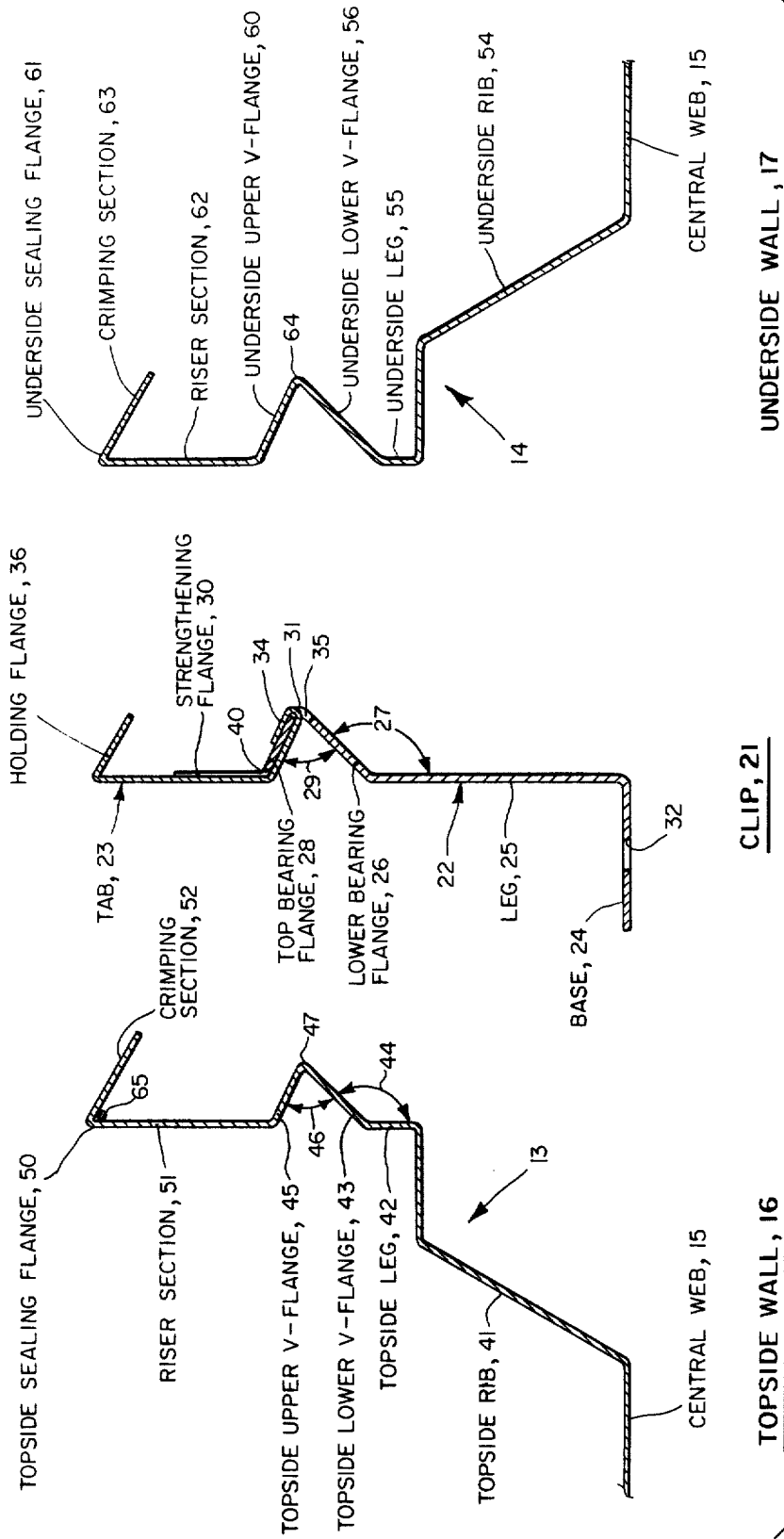


Fig. 3

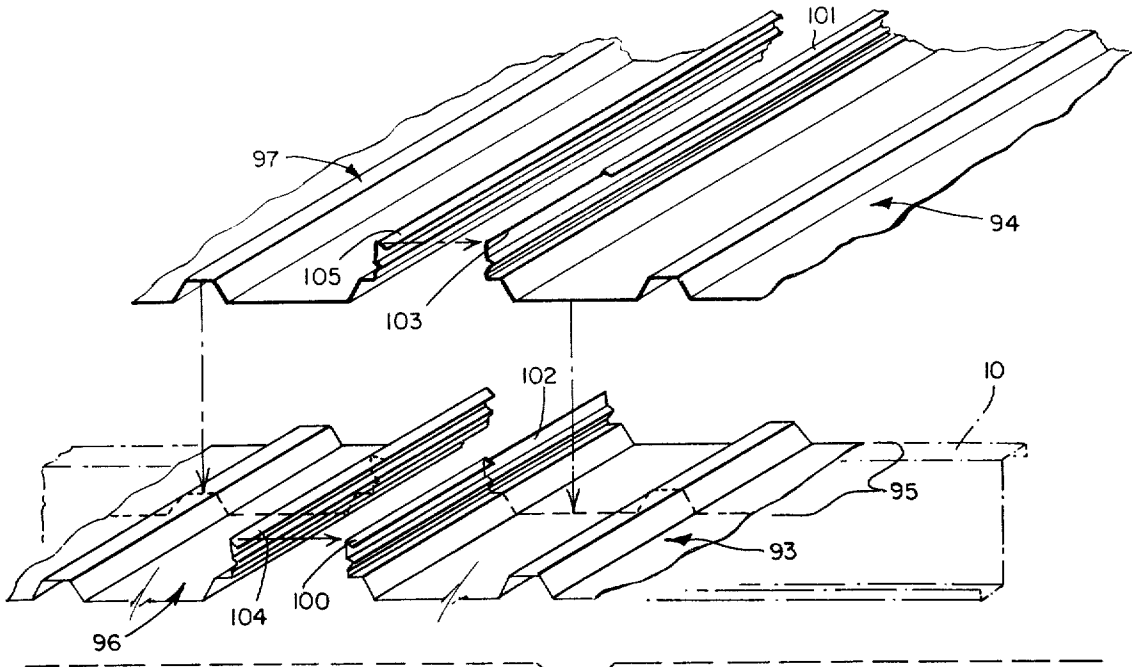


Fig. 10

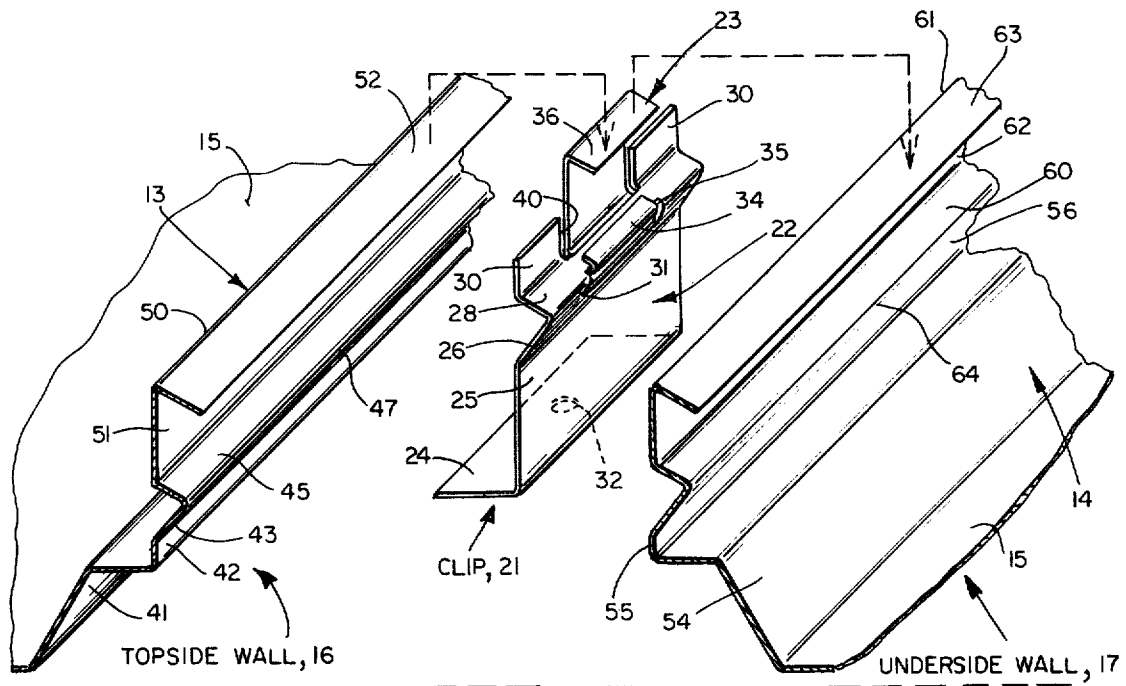


Fig. 4

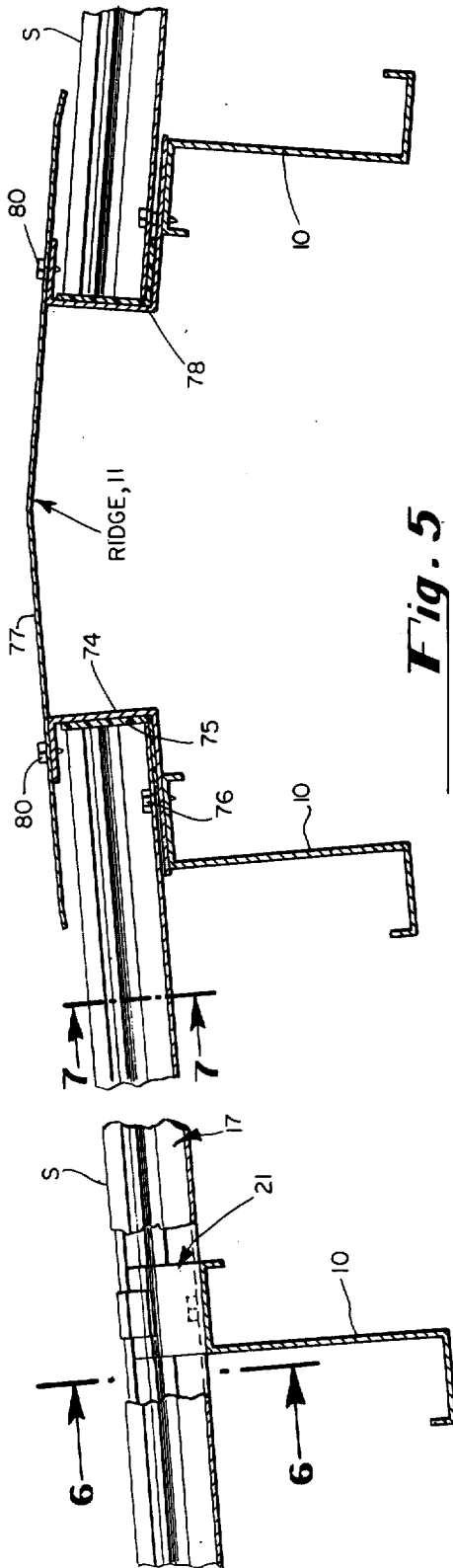


Fig. 5

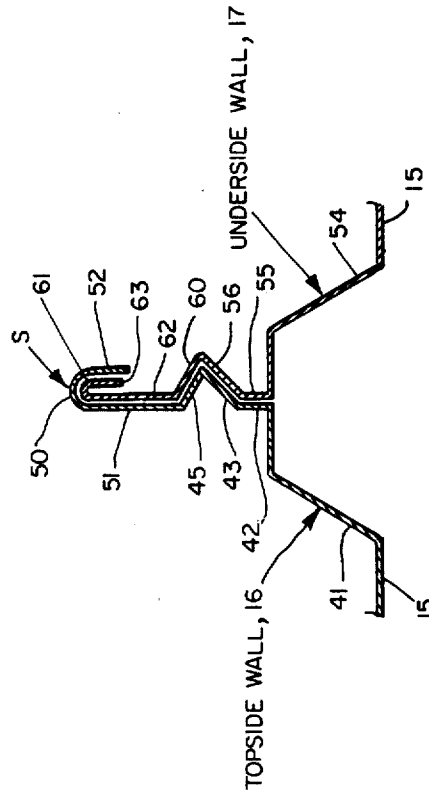


Fig. 7

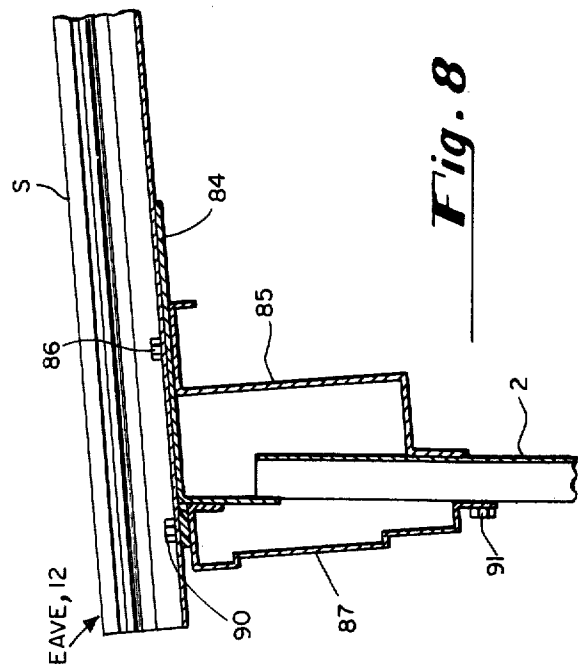


Fig. 8

METAL ROOF

This application is a division of our copending application Ser. No. 313,754 filed Dec. 11, 1972 and entitled METAL ROOF.

This invention relates to pre-engineered metal buildings and in particular relates to an improved roof structure for such buildings.

The invention contemplates improvements in standing-seam type metal roofs, the adjacent panels of which have inter-fitting seamed edges engaged with concealed clips which hold the panels down on the structure for supporting the roof.

The type of roof in question has several major advantages over built-up roofs and over metal-panel roofs using fasteners to secure the panels to one another and/or to the roof supporting structure. The greatest advantage is the water-tightness of the roof structure which is achieved by the reduction or the elimination of fasteners to secure the panels together and/or to secure the panels to the roof. The absence of fasteners not only increases the water-tightness of the roof structure but sharply reduces roof installation costs. The water-tight feature permits a substantially flatter roof with consequent savings in installation costs and in the costs of internal heating and cooling. Additionally, the clip-type structure provides for better expansion or contraction characteristics.

The invention contemplates substantial improvements in the panels and improvements in the clip construction for standing-seam roofs of the kind mentioned. The structure of the invention maximized the advantages mentioned above.

One object of the invention is to provide V-shaped sections on a hold-down clip and on abutting panel sidewalls which closely interfit with one another and establish large bearing surfaces which function to positively secure the panels down on the roof supporting structure.

Another object of the invention is to provide interfitting V-shaped sections on a clip and panel edges functioning for panel hold-down purposes and in addition serving as a track to support or guide a seaming carriage.

Another object of the invention is to provide interfitting track and hold-down V-sections on the hold-down clips and on the abutting panel sidewalls together with ribs or contoured feet at the bottom of the seam which function to resist panel spread and thereby maintain the V-sections in firm engagement.

Another object of the invention is to provide interfitting panel sidewall structure which offers high resistance to seam rupture and thereby permitting a single-fold seam which provides savings in material and reduces installation costs.

Another object of the invention is to provide interfitting panel sidewall structure having a single-fold seam which permits the seam parts to be partially formed upon manufacture and thereby reduces installation labor costs and requires a less powerful, hence less expensive seaming machine.

Another object of the invention is to provide panel structure having sidewalls which, when adjacent panels are laid down on the roof, form a starting seam having a partially crimped top portion which is subsequently finished crimped by a machine running along the seam.

Other objects and advantages of the invention will be apparent from the description below taken in conjunction with the following drawings wherein:

FIG. 1 is a perspective view of a building having a panel-type roof constructed in accordance with the invention;

FIG. 2 is a perspective view of a pair of panels of the invention set up side-by-side;

FIG. 3 is a sectional elevational view showing the shape of the hold-down clip and the shape of the top-side and underside walls of the adjacent panels, the clip and walls are shown in a position prior to being interfitted together;

FIG. 4 is a perspective view of the hold-down clip and the topside and underside walls of FIG. 3;

FIG. 5 is a sectional elevational view taken on the lines 5—5 of FIG. 1 illustrating how the panels are secured at the ridge;

FIG. 6 is a fragmentary sectional elevational view taken on the lines 6—6 in FIG. 5, except that for purposes of clarity the clip and top of the sidewalls are shown in the unseamed condition and the cross-section of the clip is shown in a heavy black line;

FIG. 6a is an enlarged view of the top part of FIG. 6 after crimping;

FIG. 7 is a fragmentary sectional elevational view taken along the lines 7—7 in FIG. 5 illustrating the panel sidewalls as locked together by the seaming operation, for purposes of clarity the parts are shown as being spaced apart;

FIG. 8 is a sectional elevational view taken on the lines 8—8 of FIG. 1 illustrating how the panels are secured at the eave;

FIG. 9 is a sectional elevational view taken on the lines 9—9 in FIG. 1 illustrating how the panels are secured at the rake;

FIG. 10 is an exploded view illustrating the construction of an over-lapping joint.

In FIG. 1, the pre-engineered metal building B has a roof 1 constructed in accordance with the invention. The panel-type side and end walls 2 and 3 and the internal framing are conventional. The framing may include the columns 4, girts 5, girders 6, end-wall rafters 7 and purlins 10. The purlins 10 support the various panels P making up the roof. The panels P extend from the ridge 11 to the eave 12. The standing seams are indicated by the dark lines. Certain other parts of the internal framing have been omitted for the sake of clarity. For further details on the side walls and framing for the type of building described, reference may be had to assignee's publication SPECIFICATION DATA PDF 372.

The panels P used in roof 1 are identical in cross-section and are set up side-by-side and have upstanding walls which are fitted together to form the seam. The shape of the panels is shown as FIG. 2, where the panels 13 and 14 are disposed side-by-side in position prior to being fitted together. Each panel includes a central web 15, topside wall 16 and underside wall 17 which respectively extend outwardly from opposite edges of the central web. The central web has strengthening ribs 20 which extend the full length of the panel. In preferred dimension, the web is approximately 24 inches wide and the walls 16 and 17 are approximately 2¾ inches in height.

The central web is adapted to be supported by the purlins 10 as the panel extends from ridge to eave. The various panels are disposed side-by-side on the roof

with the topside wall and the underside wall of adjacent panels being locked together to form a standing seam. Hold-down clips are concealed in the seam between the side walls 16 and 17. The clips are fastened down on the purlins.

The manner in which the panels are held down on the purlins by the hold-down clips and the manner in which the side walls are interfitted and locked to form the seam are important features of the invention. The structure of the clip and the side walls will next be described.

In FIGS. 3 and 4 the roof clip 21 has a lower section 22 and a tab section 23 which is moveably connected to the lower section. The lower section includes the flat base 24, leg 25 extending at right angles to the leg, a lower bearing flange 26 connected to the top of the leg and extending from the leg at an obtuse angle 27 of approximately 135°, top bearing flange 28 connected to the lower bearing flange 26 and extending outwardly over the flange 26 at an acute angle 29 of approximately 70°. An upwardly extending strengthening flange 30 is connected to the bearing flange 28. Preferably, the flange 30 is a co-planar with the leg 25.

The flanges 26 and 28 form a V-shaped section 31 which is adapted to interfit with similar V-shaped sections on the walls 16 and 17 as will be noted later.

The base 24 is adapted to be mounted directly on a purlin preferably by a self-drilling fastener extending through the base aperture 32.

The tab 23 is moveably connected to the lower section 22 as by the loop section 34 extending through the slot 35 in the bearing flange 28. As noted, the tab extends upwardly adjacent to and above the strengthening flange 30 and terminates in a bent over holding flange 36. Preferably the strengthening flange 30 has a slot 40 aligned with the tab 23. The slot allows some freedom of movement of the tab and reduces bulging in the seaming operation as will be noted later.

The topside wall 16 has a topside rib 41 and topside leg 42 which is connected to and extends upwardly from the rib. Generally centrally of the wall is the topside lower V-flange 43 which is connected to the top of the leg 42 and extends outwardly at an oblique angle 44 of approximately 135°. Connected to the flange 43 is the topside upper V-flange 45 which extends over the flange 43 at an acute angle 46 of approximately 70°. The flanges 43 and 45 form a V-section 47. As mounted on the purlins, the V-section 47 is in juxtaposition with respect to the V-section 31 on the clip so that the two sections will interfit and engage.

Connected to flange 45 is the topside sealing flange 50 comprised of a riser section 51 and a crimping section 52. Preferably the riser 51 is co-planar with the leg 42.

The underside wall 17 includes the underside rib 54, the underside leg 55, the underside lower V-flange 56, underside upper V-flange 60, the underside sealing flange 61 which includes the riser section 62 and crimping section 63. The lower V-flange 56 extends at an oblique angle of 135° with respect to the leg 55 and the upper V-flange extends at an acute angle of 70° with respect to the lower V-flange 56. The flanges 56 and 60 form the V-section 64 which, when the panel is mounted on the roof purlins, is in interfitting position with the V-section 31 on the clip.

The various components making up the clip and side-walls as mentioned above are dimensioned so that the

same will engage and interfit together. Since the clips are spotted on the purlins, this nesting takes place in the purlin area. The general condition of the seam S at a purlin is shown in FIGS. 6 and 6a. In the span between the purlins, there is no clip and the sidewalls directly nest or interfit together and this general condition is shown in FIG. 7.

The oblique angle of 135° and the acute angle of 70° are important in attaining maximum hold-down effect by the bearing flanges of the clip and by V-flanges of the sidewalls, yet permitting easy assembly of the topside wall to the underside wall.

While we will go into detail later on as to how the panels are put down on the roof, for purposes of describing the above referred to interfit, we will touch on installation technique briefly. Refer to FIGS. 3, 4, 6 and 6a.

Assume that the right hand edge of panel 14 (FIGS. 3 and 4) is locked down on the roof. The clip 21 is butted firm against the underside wall 17. The clip foregoing is done by hooking the tab 23 over the sealing flange 61 and rotating or pushing the clip down until the V-sections 31 and 64 and legs 25 and 55 engage. The base 24 is then pushed down firm on the purlin and locked by a self-drilling fastener. This anchors the underside wall 17 down on the purlin.

The topside wall 16 of the panel 13 is then butted up against the anchored underside wall 17 and clip 21. The foregoing is accomplished by hooking the sealing flange 50 over the sealing flange 61 and the tab 36 and then rotating the panel down until the V-sections 47 and 31 and legs 42, 25 and 55 engage and the panel is firm on the purlins.

In the top or crimping portion 69 of the seam (FIG. 6), the flanges 52, 36 and 63 at the purlin area (or the flanges 52 and 63 between the purlins) by extending angularly outwardly as shown are in partially crimped condition. The seam is in ready condition for a final crimping operation. This is done by a crimping machine later in the installation process and the result is to bend the flanges 52, 36 and 63 at the purlin area down into the position shown in FIG. 6a and bend flange 52 and 63 as shown in FIG. 7. In FIG. 6, topside riser section 51 is firm against the clip strengthening flange 30 (with the tab 23 moving somewhat into the slot 40) and the underside riser section 62 is also firm against the strengthening flange 30. The underside crimping section 63 extends down and is firm against the riser 62. The tab holding flange 36 is firm against the crimping section 63. The topside crimping section 52 is down firm against the underside crimping section 63. The legs 42 and 55 of the topside and underside walls are in the firm engagement with the leg 25 of the clip. The V-section 31 of the clip is nested with the V-sections 47 and 64 of the side walls.

The topside sealing flange 50 by fitting over and enveloping the tab and the underside sealing flange and by that the parts are forced together by the crimping operation a seal is formed along the top of the seam.

A preferred type of crimping machine or roofers carriage is shown in U.S. Pat. No. 3,773,005 assigned to the assignee of this invention. With reference to that patent, it will be noted that the interfitting V-sections 47 and 64 serve as guides or tracks for the machine.

Preferably the topside sealing flange 50 is provided with a strip of caulking material 65 so that when the topside sealing flange 50 is put over the tab 23 (and the

sealing flange 61), the caulking material spreads out to form a sealing barrier. For purposes of clarity, we have not shown the caulking material in FIGS. 6, 6a, and 7.

The manner in which the clip operates to hold down the panels will next be explained. By virtue of the nesting of the V-sections 31, 47 and 64, the bearing flange 26 of the clip engages the underside lower V-flange 56 while the other bearing flange 28 of the clip engages the topside upper V-flange 45. Any lifting or upward motion of the right hand panel 14 will be resisted by the bearing flange 26. Any lifting or upward motion of the left hand panel 13 will be resisted by the bearing flange 28. Thus the V-sections of the clip being nested within the V-sections of the sidewalls function to lock or anchor the panels down in a position on the roof. Since there is a clip at each purlin, the holding force is substantial.

The ribs 41 and 54 on the walls 16 and 17 are primarily for the purpose of maintaining the V-sections 47 and 64 of the walls engaged with the V-section 31 of the clip. The ribs 41 and 54 provide substantial resistance to spreading or separation of the walls 16 and 17.

Without ribs, substantial spreading could occur under certain load conditions and one or other of the wall flanges 45 and 56 could become disengaged with the hold-down bearing flanges 26 and 28 of the clip and therefore allow one or both of the panels to lift out of position.

FIG. 7 represents the condition in the span between the purlins. While we have shown the panels of the topside and underside walls as being spaced apart, this has been done only for clarity of illustration. The topside riser 51 is firm against the underside riser 62. The underside crimping section 63 is bent back firm against the underside riser 62. The topside crimping section 52 is bent down and firm against the underside crimping section 63. Thus the sealing flange 50 envelops the underside sealing flange 61 and forcing the parts together forms a seal. The legs 42 and 55 of the side walls are in substantial engagement. The topside lower V-flange 43 engages the underside lower V-flange 56 and the underside upper V-flange 60 engages the topside upper V-flange 45. The ribs 41 and 54 continue to function to resist spreading of the walls 16 and 17. Thus in the span areas, engagement of the V-flanges and the resistances of the ribs augment the holding power of the clips.

As will be apparent, the function performed by the V-sections and the function performed by the ribs extends throughout the length of the panel and maintains the integrity of the whole standing seam.

The preferred manner of attaching the panels to the roof supporting structure will next be described.

First, the starting and finish panels are formed. These panels are made by slitting regular panels such as the panels 13 and 14. A starting and finishing panel may be made by slitting one of the regular panels and using the portion having the underside wall as a starting panel and the portion having the topside wall as the finish panel. In the embodiment shown herein a starting panel is formed by slitting along the lines 66 of panel 14 and using the portion with the underside wall 17. The finish panel is made by slitting along the dotted lines 67 in panel 13 and using the portion having the topside wall 16.

A support angle 67 is mounted on the purlins and extends from eave to ridge. The starting panel 70 is dis-

posed on the purlins and on the support angle and is located transversely at the rake 71 (FIG. 9) and also at the ridge 11 (FIG. 5). Normally, the location of the edge of the panel at the ridge will be a fixed distance from the ridge purlin. A line is stretched across the ridge so that as the panels are installed they will all be in line and set at the desired fixed distance. After the starting panel is located, it is locked down by the self-drilling fasteners 72 inserted at each of the purlins and between purlins on 12 centers into the support angle. Normally, the starting panel is also temporarily fastened at the ridge area so as to prevent spreading or bulging.

The hold-down clips are then installed in each purlin except at the ridge purlin and at the eave strut. The clips are put into place in the manner previously described. Then the next adjacent panel 73 (FIG. 9) is installed by putting its topside wall 16 over the underside wall 17 of panel 70. The clips are then spotted and fastened down to anchor the left hand or underside wall of panel 73. After installing 7 or 8 panels, the same are then crimped with the machine mentioned heretofore. The process is then repeated until reaching the finishing panel. The finishing panel will be installed by first interfitting its topside wall with adjacent underside wall and then locking down its outside edge similarly as was done with the fasteners 72.

In installing the panels, it is preferred that at both the ridge and at the eave ends, two beads of caulking be run down on the topside wall. The beads will then engage the underside wall and seal against the entry of water at the ridge and eave ends of the seam.

After all of the panels have been installed and seamed, the temporary fasteners at the ridge are removed. The ridge channel 74 (FIG. 5) is provided with an L-shaped sealing material 75. The panels are then lifted slightly and the channel and sealing material are slid under the edge of the panels making sure the panel edges bite into the material 74. Then the panels are locked down by the fasteners 76 spaced along the ridge at approximately 4 inches centers.

The panel on the other side of the building are then installed in the same manner. Then the ridge, the eave and the rake trim are put into place as described below.

Referring to FIG. 5, the ridge cover 77 is mounted on the respective ridge channels 74 and 78 and are held down by the fasteners 80 spaced along the ridge at approximately 12 inches centers. Referring to FIG. 9, the rake trim 81 is secured by the fasteners 82 and 83. Incidentally, at the ridge, the rake trim on each side of the roofing extends underneath the ridge cover 77 and is locked in position by a fastener.

Referring to FIG. 8, the eave flashing 84 is supported by the eave strut 85. The flashing extends along the length of the eave. The panels and flashing are locked down on the eave strut by the fasteners 86 which extend along the eave at approximately 8 inches centers. The eave trim 87 is held in place by the fasteners 90 and 91.

In cases where the length of the roof from the ridge to the eave requires more than one length of panel, the same are overlapped at a purlin and are preferably held down by fasteners rather than by a clip. Also, the crimping sections on the sidewalls are notched whereby to minimize the layers of metal that must be crimped.

With reference to FIG. 10, the panels 93 and 94 represent the lower row of panels which extend from the

eave say to the center of the roof. The panels 95 and 96 represent the upper row of panels which extend from the center to the ridge. The row of upper panels is adapted to overlap the lower row, the overlap area being indicated at 97 and extending in order of approximately 8 inches.

In the overlap type of construction the panels are put down similarly as in the non-overlap arrangement. To begin the installation, a starting panel such as panel 93 is put down to extend from the eave to the middle of the roof. Then the next panel 94 is put down to overlap at 95 and extend up to the ridge. The hold-down clips are installed except at the overlap area. Following this the panel 96 and then the panel 97 are put down, etc.

To avoid excess layers of metal at the overlapped area, the underside walls are notched. Thus in panels 93 and 94, the underside crimping sections 100 and 101 are respectively notched at 102 and 103. When the topside crimping sections 104 and 105 of the panels 96 and 97 are fitted over the crimping sections 100 and 101 there will be only a double layer of metal in the notched area.

The absence of additional layers at the notched area is important because it avoids the development of internal stresses which might otherwise cause fracture and lead to leakage especially with contraction and expansion of the roof due to temperature changes. Additionally, the absence of additional layers of metal does not put undue strains on the carriage during the seaming operation.

It will be understood that in some locations a layer of insulation is used on the roof and ordinarily this will comprise batts which are draped over the purlins. In the event insulation is used, it is put down just prior to the installation of a panel.

We claim:

1. A standing seam connecting an adjacent pair of panels together, the seam being formed by interfitting topside and underside walls on the respective panels, the first panel including an underside wall having:
 - a. an underside rib to be disposed adjacent to the support structure for the roof;
 - b. an underside leg connected to and extending upwardly from the underside rib;
 - c. an underside lower V-flange connected to the underside leg and extending outwardly at an oblique angle thereto;
 - d. an underside upper V-flange connected to the underside lower V-flange and extending outwardly and over the underside lower V-flange at an acute angle thereto;
 - e. an underside sealing flange having a riser section connected to the underside upper V-flange and extending upwardly therefrom and also having a crimping section connected to the riser section and extending outwardly at an acute angle thereto;
- the second panel including a topside wall having:
 - a. a topside rib to be disposed adjacent to the supporting structure for the roof;
 - b. a topside leg connected to and extending upwardly from the rib and generally parallel to and substantially engaged with the underside leg;
 - c. a topside lower V-flange connected to the topside leg and extending outwardly at an oblique angle thereto and being substantially engaged with the underside lower V-flange;

- d. a topside upper V-flange connected to the topside lower V-flange and extending outwardly and over the topside lower V-flange and at an acute angle thereto and being substantially engaged with the underside upper V-flange;
- e. a topside sealing flange having a riser section connected to the topside upper V-flange and extending upwardly therefrom and being in substantial engagement with the underside riser section and also having a crimping section bent back on and in substantial firm engagement with the underside crimping section, the riser section and crimping section of the topside sealing flange forming a cover over the underside sealing flange and thereby sealing the seam against entry of water.
2. A construction in accordance with claim 1 further including caulking between the topside and underside sealing sections.
3. A construction in accordance with claim 1 wherein the topside and underside ribs are mirror images.
4. A construction in accordance with claim 1 wherein each said obtuse angle is approximately 135° and each said acute angle is approximately 70°.
5. A standing seam connecting a pair of adjacent roof panels together in combination with a hold-down clip concealed in the seam for holding the panels on the roof supporting structure, the seam being formed by interfitting topside and underside walls on the respective panels enveloping the clip by that:
 - the first panel including means for mounting the panel on roof supporting structure and also including a topside wall having a V-shaped section;
 - the second panel including means for mounting the panel on the roof supporting structure and also including an underside wall having a V-shaped section;
 - a hold-down clip disposed between the topside and underside walls and having a lower section including a base mounting the clip on the roof supporting structure and V-shaped section above the base interfitting with the V-section on the topside wall and also interfitting with V-section on the underside wall, the V-sections of the clip bearing on V-sections of the respective walls for holding the respective panels down on the roof supporting structure; and
 - a sealing flange on said topside wall, the sealing flange extending over and being firmly crimped against the top of said underside wall whereby to seal the seam against entry of water.
6. A construction in accordance with claim 5 further including caulking between said sealing flange and the top of said underside wall.
7. A roof panel comprising:
 - a central web;
 - an underside wall and a topside wall respectively extending outwardly from opposite edges of the central web;
 - the underside wall including:
 - a. an underside rib connected to the central web;
 - b. an underside leg connected to and extending upwardly from the underside rib;
 - c. an underside lower V-flange connected to the underside leg and extending at an oblique angle thereto;

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- d. an underside upper V-flange connected to the underside lower V-flange and extending over the lower V-flange and at an acute angle thereto;
 - e. an underside sealing flange having a riser section connected to the underside upper V-flange and extending upwardly therefrom and also having a crimping section connected to the riser section and extending outwardly at an acute angle thereto;
- the topside wall including:
- a. a topside rib connected to the central web;
 - b. a topside leg connected to and extending upwardly from the topside rib and generally parallel to the underside leg;
 - c. a topside lower V-flange connected to the topside leg and extending at an oblique angle thereto, the oblique angle being substantially the same as first said oblique angle;
 - d. a topside upper V-flange connected to the topside lower V-flange and extending over the topside lower V-flange and at an acute angle thereto, the acute angle being substantially the

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- same as first said acute angle.
 - e. a topside sealing flange having a riser section connected to the topside upper V-flange and extending upwardly therefrom and substantially parallel to said underside riser section and also having a crimping section connected to the topside riser section and extending outwardly at an acute angle thereto, the acute angle being substantially the same as first said acute angle.
8. A construction in accordance with claim 7 wherein each said oblique angle is approximately 135° and each said acute angle is approximately 70°.
9. A construction in accordance with claim 7 wherein said central web is provided with a plurality of ribs.
10. A construction in accordance with claim 7 wherein said underside lower and upper V-flanges form a V-shaped section which points inboard of the central web and wherein said topside lower and upper V-flanges form a V-shaped section which points outboard of the central web.
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