

PATENT SPECIFICATION

DRAWINGS ATTACHED

L069.386



L069.386

Date of Application and filing Complete Specification: Aug. 4, 1964.

No. 31184/64.

Application made in United States of America (No. 299779) on Aug. 5, 1963.

Complete Specification Published: May 17, 1967.

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Index at acceptance:—E1 W(4B2, 4B4, 4B10, 4B14, 4B17, 4B23, 4B36, 4B45, 4B52, 4B60, 4B69, 4B73);
B3 J(1B, 2A, 2F, 3, 4)

Int. Cl.:—E 04 b 1/18

COMPLETE SPECIFICATION

Improvements in or relating to Sectional Building Structures

5 We, KAISER ALUMINUM & CHEMICAL CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of 300 Lakeside Drive, Oakland 12, California, United States of America, 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 panels which can be joined together to form a continuous surface. It has particular application to a roof, wall or ceiling structure of a type utilizing a plurality of roofing, wall or ceiling panels of metal channel section, adjacent margins of which are interconnected to provide a functionally continuous roof, wall or ceiling structure which can be with or without weather-sealing. A specific object of the invention is to provide a roof structure wherein side walls of adjacent channel sections are coupled directly to one another by a weather-tight coupling, and in a manner such as to provide a structure having sufficient inherent strength for ordinary roof loads and spans.

15 In general, the invention aims to provide an improved building exterior of painted or bare embossed aluminium or other metal, of continuous, interlocked panels, and smooth interior wall surfaces of sheet metal, plywood or other sheet material having a smooth surface clipped, sheet metal screwed, or otherwise fastened to the inwardly outstanding coupled flanges of the panels, with or without insulation in the spaces between the exterior and interior panels. It is contemplated that such construction may be embodied either in the outer roof or walls of a building.

20 An important object of the invention is to provide a roof or wall structure consisting of panels of any required length, joined by marginal couplings which are provided with

means for arresting capillary travel of moisture between the mating surfaces of the coupling, to the extent that the entry of moisture into the building is prevented. A further object is to provide such a construction which is free of fastener holes or fasteners in the outer surfaces of the roof or walls.

In one embodiment, the invention provides a ceiling or roof structure wherein a series of panels of shallow rectangular channel sections are arranged with their concave sides facing upwardly and have parallel vertical side flanges which are abutted against one another in direct face-to-face engagement and are coupled, one to another along their upper margins and suspended from a supporting frame by attachment of such coupled upper margins to the under side of the frame with the engaging flanges mutually bracing one another.

Coupling of the margins of the side walls is effected by means of nestable beads or sleeves on the respective flanges, the bead of one flange being nested within a somewhat larger bead or sleeve of the adjacent flange. While it would be possible to effect the coupling of such beads one to another by longitudinally sliding the smaller bead into the larger bead, such an operation has been found to be quite difficult and time consuming and is likely to result in damaging the metal channel structure of the panels in the application of the high pressure required to effect such longitudinally slidable coupling. Furthermore, even though the beads are preformed for sufficiently close coupling to require high pressure for assembling them in that manner, the fully coupled beads will have a residual looseness of coupling which is undesirable. To avoid the possibility of rain being blown through the coupled joints, or of rattling vibrations occurring when high winds are blowing against the roof or ceiling struc-

[Price 4s. 6d.]



ture, it is desirable that the beads be tightly coupled to one another.

With the foregoing in mind, the invention aims to provide a method of coupling the beaded margins of channel section panels one to another with a tight engagement between the coupled beads. This is effected through the use of a hand or power operated set of opposing pressure rollers, shaped to develop the contour of the finished, interlocked beads. The rollers are caused to travel the length of the initially loosely engaged contiguous margins and, with the simultaneous application of predetermined pressure, to press the mating margins into tightly coupled telescoped bead assembly.

According to one aspect of the invention, a building structure comprises a plurality of spaced supporting members, a series of interlocked metal panels of channel configuration and self-supporting capacity affixed to and closing the space between said spaced supporting members, each of said panels having a web and a pair of side walls projecting outwardly from opposing side edges thereof and at an angle thereto, a first side wall of each panel being in substantially full face-to-face and supporting relationship with a second and opposing side wall of an adjoining panel, and having a tubular bead along its outer edge, said second opposing side wall of each panel having a deformable tubular sleeve along its outer edge, said sleeve being positively clamped about and fully enclosing in surface-to-surface engagement the tubular bead on the outer edge of the first side wall of an adjoining panel for substantially the entire length of said bead and said adjoining panels and providing a rigid substantially continuous watertight fully enclosed coupling between said abutting side walls of adjoining panels for substantially the entire lengths thereof, and means affixing said coupled side walls and the panels provided therewith to the supporting members.

According to another aspect of the invention, a method of coupling together and simultaneously forming a continuous rigid moisture-proof joint between the adjoining side walls of a pair of channel-shaped panels wherein the first side wall of one panel is provided with a tubular bead at the free marginal edge thereof and wherein the opposing side wall of the other panel is provided with an open sleeve at the corresponding free marginal edge thereof comprises the steps of inserting the tubular bead of the first panel loosely within the open sleeve of the second panel, placing a plurality of opposed rollers about the outer peripheral portions of said sleeve and progressively deforming and closing said sleeve about said tubular bead while advancing said plurality of opposed rollers from one end of said sleeve to the other whereby the panels

when coupled together present a substantially flat surface on one side thereof.

In order that the invention may be more readily understood, several embodiments will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a fragmentary perspective view of one end side or side of a suspended ceiling structure embodying the invention;

Fig. 2 is a fragmentary end view of portions of coupled ceiling panels and their suspending connection to a supporting beam, a fragment of which is outlined in broken lines, parts of the suspending bracket being broken away and shown in section;

Fig. 3 is a side view of the upper portion of the supporting bracket illustrating its connection to a supporting beam, parts being broken away and shown in section;

Fig. 4 is an end view of fragmentary portions of adjoining ceiling panels being coupled to one another in accordance with the invention;

Fig. 5 is a plan view of the parts seen in Fig. 4;

Fig. 6 is a perspective view of a fixing strap for use with an improved panel structure in accordance with the invention;

Fig. 7 is a cross-sectional view of a roof panel structure incorporating the connector of Fig. 6;

Fig. 8 is a cross-sectional view of suspended ceiling panel structure incorporating the said fixing strap;

Fig. 9 is a cross-sectional view of an assembly of panels joined in accordance with the invention, wherein two series of joined panels are nested together in opposed relation to provide a cavity structure which is equally useful for insulated ceiling or side wall structure; and

Fig. 10 is a fragmentary detail sectional view of a panel structure embodying a modified joint structure.

Referring now to the drawings in detail, we have shown therein, as an example of one form in which the invention may be embodied, a metal ceiling structure suitable for outdoor use, as in canopies for filling stations, drive-in restaurants, sandwich and soft drink dispensaries, etc. The underneath side of a ceiling structure is the finished side, the visible parts consisting of a series of parallel elongate panel faces defined by a plurality of flat webs 10 separated by parallel longitudinal recesses 11 and 12. The recesses 11 are defined by upwardly indented beads 13 in the main bodies of respective channel section panels, and the recesses 12 are defined co-operatively by corner beads 14 joining the main horizontal body of a channel section to its upwardly projecting side walls 15 and 16 respectively.

It will now be apparent that the invention provides a plurality of panels of shallow rect-

angular channel section each including a main body portion adapted to be disposed in the horizontal plane, and a pair of flat, parallel side walls 15 and 16 adapted to extend vertically upwardly and to establish flat face-to-face engagement with corresponding side flanges of adjoining panels. Each flange 15 has at its upper end a cylindrical tubular bead 17. Each flange 16, in the assembled ceiling structure, has a tubular socket sleeve 18 of cylindrical configuration slightly larger in diameter than the bead 17, its inner surface in contact with the outer surface of a corresponding bead 17. The coupling is sufficiently close to be weather-tight.

In a roof or ceiling structure of the type described, the coupled panels are hung from the under sides of a plurality of transverse rafters or supporting beams 21 of upstanding channel section. Suspension is provided for by the attachment clamp shown in Figs. 2 and 3. Each clamp, of stamped sheet metal, comprises respective jaws 22 and 23 adapted to clamp a sleeve 18 between them. They have respective arms 24 and 25 which are connected by a clamp bolt 26, the arm 25 having a positioning tang 27 struck out from its central region and engaged in an aperture 28 in the arm 24. Arm 25 is further provided with an ear 29 bent outwardly therefrom at right angles and adapted to engage the underside of the bottom flange of support beam 21. Arm 24 projects upwardly beyond the ear 29 and is formed with a return-bent yoke 30 including an arm 31 in laterally spaced parallel relation to arm 24. The arms 24 and 31 are provided with registering notches 32 adapted to receive the lower flange of the beam 21. A clamp screw 35 is threaded downwardly through the connecting web of yoke 30 for engagement with the flange of beam 21 and to clamp the same against the lower edges of notches 32.

With the ceiling panels suspended from overhead beams 21 by the suspension clamps 22—35, the weight of the horizontal body portions of the ceiling panels will tend to press side flanges 15 and 16 into frictional engagement with one another, thus providing mutual bracing support of the sides of the panels against one another and preventing any gaping apart of the lower margins of the flanges 15 and 16. With suitable suspension support by clamps 22—35 at suitably spaced intervals (e.g. of six feet along the length of each pair of coupled beads) an adequately supported and rigidified ceiling structure of fairly light gauge metal is provided. For example, a series of panels, each one foot in width and with approximately 4 inch divisions between beads 13, can be satisfactorily fabricated from aluminium alloy sheet as thin as .019 SWG and will provide a ceiling structure of fully adequate rigidity.

One side or end of the ceiling structure

(defined by aligned ends of the panels) may be mounted to a vertical wall of a building structure by means of an attachment strip F'. Attachment strip F' can be secured to the ends of the ceiling panels by bolts, screws, rivets, or by the small clamp units 37 disclosed in Fig. 1.

Method of Assembling Panels

Referring now to Figs. 4 and 5, the sleeve 18 is initially fabricated as an open curled lip or roll 18', the free edge of the roll being spaced from the diametrically opposed portion thereof by a gap sufficient to receive the bead 17 of the adjoining panel. Assembly is effected simply by arranging the adjoining panels with their respective ends properly aligned, then fitting the curled roll 18' over the bead 17, and then closing the roll 18' around the bead 17, beginning at one end and proceeding along the length of the roll 18' to its other end. This is done by utilizing a portable rolling tool shown in Figs. 4 and 5 and comprising a pair of peripherally grooved pressure rollers 40 suitably mounted on a frame 41 having a handle 42 for manipulating the tool. Power operation is provided for by an electric motor 52 suitably mounted at 43 on the end of frame 41 and driving the rollers 40 through suitable reduction gearing. Merely for the purpose of illustration, such reduction gearing is indicated as comprising a worm 44 on the end of the motor shaft, meshing with respective worm wheels 45 on the shafts of the rollers 40 and driving the same in opposite directions such that the rollers 40, by frictional gripping of the roll 18', will draw the tool along the roll 18', turning the roll 18' inwardly as the tool progresses along the bead. Thus the operator is required only to guide the tool and to exert a very moderate push against the tool to cause it to travel along the bead.

Modified Form—Figs. 6—8

Fig. 6 illustrates a fixing strap, which can be utilized to tie down a series of connected panels upon a plurality of underlying rafters 55 shown in Fig. 7, or to suspend a series of panels from overhead rafters 55', as shown in Fig. 8. The strap is fabricated of thin metal strip, bent to provide an intermediate body 56, an open curl 57 at one end thereof, and a foot 58 bent at right angles from its other end. Foot 58 is adapted to be secured to a rafter 55 or 55' by a nail 59 driven through a nail hole 60 in the foot. Body 56 is adapted to be sandwiched between adjacent side flanges 15, 16 of attached panels, and curl 57 is adapted to be locked between the coupled bead 17 and sleeve 18 of the panels. The curl 57 is initially shaped to conform to the interior of open roll 18' as seen in Fig. 4, and is curled inwardly at the same time as the roll 18' is closed to form sleeve

18. When thus locked between bead 17 and sleeve 18, curl 57 provides a very secure anchorage of the strap to the coupled panels, sufficient to securely hold the panels down against rollers 55 as in Fig. 7 or to suspend the inverted panels as in Fig. 8.

Cavity Structure—Fig. 9

Fig. 9 illustrates how two series of coupled panels can be nested in opposed relation, with the coupled flanges of one series overlapping the coupled flanges of the opposed series, and with the overlapped flanges tied together by bolts 61. Thus a cavity structure, with dead air cells which can be utilized for heat insulation, is provided. For additional insulation, the dead air spaces can be filled with rock wool or other insulation material. Such a cavity structure is very strong, providing high load bearing capacity (e.g. for carrying roof loads) and wind load bearing capacity (e.g. when utilized for vertical walls).

Modified Form—Fig. 10

As shown in Fig. 10, the coupling between bead 17 and sleeve 18 can be moisture-sealed by a strip of sealing tape 65 rolled into the joint as the roll 18' is closed, or by a coating of mastic applied to the interior surface of roll 18' before closing it on bead 17. Thus a non-leaking roof can be provided, or the air cells of the structure of Fig. 9 can be hermetically sealed.

The structure can be applied to numerous uses, including roof or ceiling structures wherein the panels can be installed either with their open channel sides facing upwardly or downwardly as described above; or in vertical wall structures wherein the panels can be arranged with their open sides facing either inwardly or outwardly as specifications for particular jobs may dictate. The dead air cell, cavity structure disclosed in Fig. 9 is particularly adaptable for wall structures where heavy loads are to be borne, the double-channel, tubular structure of Fig. 9 being especially suitable for carrying heavy loads in longitudinal compressive stress. This structure is also effective for wind-load bearing up to heights of 10 feet in areas where winds are experienced. The double-channel structure of Fig. 9 is especially advantageous for its heat insulating properties both in vertical walls and in ceilings and roofs, either with unfilled air spaces therein or with the spaces filled with insulation material. It is ideal for beach huts or like buildings.

While I have shown the coupling bead 17 and sleeve 18 as being generally cylindrical in the closed coupling, it should be understood that these coupling elements can be of other cross sectional shapes, such as triangular, square, hexagonal, octagonal, etc.

In lieu of the use of the sealing tape 65 or mastic coating for moisture-sealing the joints between panels, the bead 17 and sleeve 18 may be coupled to one another in metal-to-metal contact, as in Fig. 2, moisture sealing being provided for in this instance by a capillary trap in the form of a small channel 68 embossed inwardly into the wall of bead 17 below its crown on the side thereof which is joined to the web 15 (i.e., on the side of the joint which is open to the exterior thereof) said channel defining a small capillary groove extending the full length of the panel-coupling joint, and being of sufficient volume to arrest any capillary travel of moisture which may enter the open extremity of the crevice between bead 17 and sleeve 18 and commence to travel circumferentially in said crevice by capillary action. The same capillary trap can be embodied in the construction shown in Fig. 7 including a strap interposed between the bead 17 and sleeve 18, since these two parts will be tightly coupled to one another in direct contact at all points along the length of the joint except where the joint is expanded slightly by the interposed strap curl 57. This will automatically result from the use of our improved method of closing the joint.

The satisfactory operation of a building structure embodying the invention in a fully leak-free operation of maintaining a dry interior when subjected to test conditions simulating 2 inches of rain per hour driven by a wind machine at 65 M.P.H. has been demonstrated by test in a laboratory of the city of Los Angeles, Harbor Department.

For mounting the strap 56—58 to supports, the feet 58 can be attached by nails, screws, bolts, rivets or equivalent fasteners, or by welding.

WHAT WE CLAIM IS:—

1. A building structure comprising a plurality of spaced supporting members, a series of interlocked metal panels of channel configuration and self-supporting capacity affixed to and closing the space between said spaced supporting members, each of said panels having a web and a pair of side walls projecting outwardly from opposing side edges thereof and at an angle thereto, a first side wall of each panel being in substantially full face-to-face and supporting relationship with a second and opposing side wall of an adjoining panel, and having a tubular bead along its outer edge, said second opposing side wall of each panel having a deforming tubular sleeve along its outer edge, said sleeve being positively clamped about and fully enclosing in surface-to-surface engagement the tubular bead on the outer edge of the first side wall of an adjoining panel for substantially the entire length of said bead and said adjoining panels and providing a rigid substantially continuous watertight fully enclosed



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deformable

18. When thus locked between bead 17 and sleeve 18, curl 57 provides a very secure anchorage of the strap to the coupled panels, sufficient to securely hold the panels down against rollers 55 as in Fig. 7 or to suspend the inverted panels as in Fig. 8.

Cavity Structure—Fig. 9

- Fig. 9 illustrates how two series of coupled panels can be nested in opposed relation, with the coupled flanges of one series overlapping the coupled flanges of the opposed series, and with the overlapped flanges tied together by bolts 61. Thus a cavity structure, with dead air cells which can be utilized for heat insulation, is provided. For additional insulation, the dead air spaces can be filled with rock wool or other insulation material. Such a cavity structure is very strong, providing high load bearing capacity (e.g. for carrying roof loads) and wind load bearing capacity (e.g. when utilized for vertical walls).

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The satisfactory operation of a building structure embodying the invention in a fully leak-free operation of maintaining a dry interior when subjected to test conditions simulating 2 inches of rain per hour driven by a wind machine at 65 M.P.H. has been demonstrated by test in a laboratory of the city of Los Angeles, Harbor Department.

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coupling between said abutting side wall of adjoining panels for substantially the entire lengths thereof, and means affixing said coupled side walls and the panels provided therewith to the supporting members.

2. A building structure according to claim 1, wherein a panel has a reinforcing corner bead at the junction between a side wall and the web thereof.

3. A building structure according to any preceding ~~to any preceding~~ claim wherein the adjoining panels are suspended from a supporting member adjacent the point of coupling thereof.

4. A building structure according to any preceding claim, wherein the means affixing said coupled walls and panels to the supporting members comprises a fixing strap including a body portion tightly coiled and arranged in full surface-to-surface contact with and between both said bead and sleeve on a pair of adjoining panels and a foot at the other end of said body portion fastening said strap to a supporting member.

5. A building structure according to claim 1, 2 or 3, wherein a coupling means is used for adjoining panels, said coupling means including a split clamp adjustably engaging the outer peripheral portion of a bead and sleeve on adjoining panels.

6. A building structure according to any preceding claim wherein the tubular bead on the outer edge of said one side wall is provided with a capillary groove.

7. A composite structure comprising two building structures according to claim 1, 2 or 3, the panels of each of said building structures being arranged in opposed nested relationship and with adjacent pairs of the coupled opposed side walls of a pair of panels being overlapped with one another and secured together to define a plurality of dead air cells between the opposed panels.

8. A building structure, substantially as hereinbefore described and as shown in Figs. 1 to 5, Figs. 6 to 8, Fig. 9 or Fig. 10 of the accompanying drawings.

9. A method of coupling together and simultaneously forming a continuous rigid moisture-proof joint between the adjoining side walls of a pair of channel-shaped panels wherein the first side wall of one panel is provided with a tubular bead at the free marginal edge thereof and wherein the opposing side wall of the other panel is provided with an open sleeve at the corresponding free marginal edge thereof comprising the steps of inserting the tubular bead of the first panel loosely within the open sleeve of the second panel, placing a plurality of opposed rollers about the outer peripheral portions of said sleeve and progressively deforming and closing said sleeve about said tubular bead while advancing said plurality of opposed rollers from one end of said sleeve to the other, whereby the panels when coupled together present a substantially flat surface on one side thereof.

10. A method according to claim 9 including the step of loosely sandwiching the deformable tubular beaded portion of a support engaging connector clip between the tubular bead of the one panel and the sleeve of the other panel prior to the engagement of the sleeve by said opposed rollers and, during the progressive deformation and closing of said sleeve about said tubular bead, also effecting a deformation and closing of the tubular beaded portion of the clip about the tubular bead of the panel.

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