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S. MOLLINGER
STRUCTURAL ASSEMBLY

3,564,784

Filed March 12, 1969

2 Sheets-Sheet 1

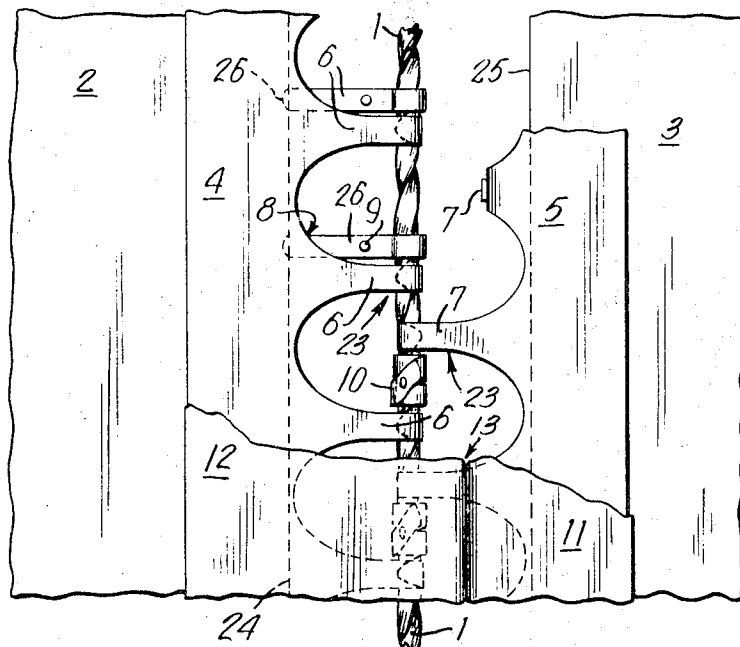


FIG. 1

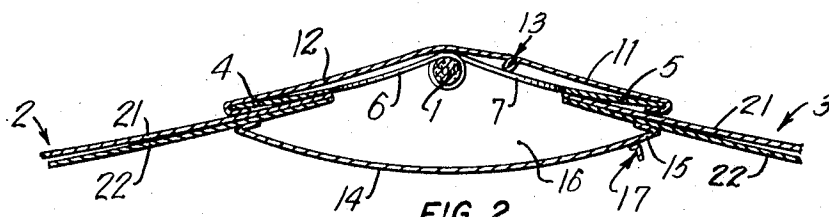


FIG. 2

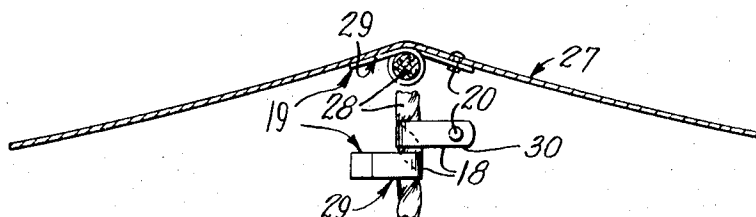


FIG. 3

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2 Sheets-Sheet 2

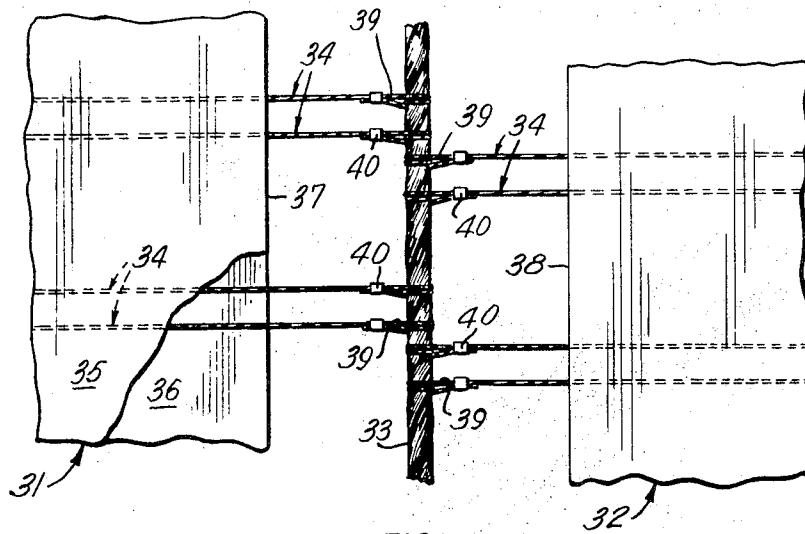


FIG. 4

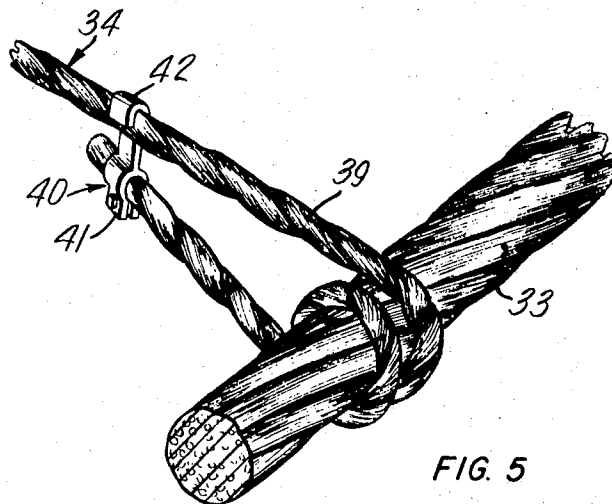


FIG. 5

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3,564,784
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14,876

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12 Claims

ABSTRACT OF THE DISCLOSURE

A structural assembly for use as roofs or walls in buildings comprising flexible sheets of material, supporting cables and means for connecting the sheets to the support cables.

BACKGROUND OF INVENTION

(1) Field of invention

The present invention relates to improvements in structural assemblies and particularly to improvements in the structural connection of flexible sheets such as plastics or coated fabrics to elongated support means such as cables or rods.

This invention will facilitate the use of flexible sheets of plastics or coated fabrics for the enclosure, i.e., the roofing and siding, of arenas, exhibition halls, industrial and other permanent or temporary buildings.

(2) Description of prior art

It is common at the present time to use rigid or near rigid roofing and rigid or near rigid siding for such buildings. It is also common at the present time to support the rigid or near rigid roofing on purlins and the purlins on trusses which consist of top chords, bottom chords, struts and diagonals and thereby making the roof an item of major expense, specially in the case of long spans.

SUMMARY OF INVENTION

The present invention relates to a structural assembly, which, by way of the particular structural connection of flexible sheets to cables, permits roofs of large spans and unlimited lengths consisting largely only of flexible sheets of plastics or coated fabrics and cables, to be constructed simply and inexpensively. The present invention may also be used as the siding of buildings. The invention further relates to providing a substantially weatherproof structural assembly.

It is an object of the present invention to build roofs and side enclosures of large buildings at considerable economy.

Another object of the invention is to use cables as the sole support of the roofing.

Another object of the invention is to use flexible sheets of plastics or coated fabrics, single or laminated, as the sole roofing skin.

Another object is to simplify the connection of sheets to cables to such a degree that unskilled labor may be employed in effecting the connection.

Another object is to be able to effect the connection and weatherproofing from the inside of the building only.

Another object of the invention is to be able to dismantle the roofing and siding of a building and re-use it somewhere else as may be desirable for hangars or portable or temporary buildings.

The invention is directed toward a structural assembly comprising a cable and a flexible sheet located adjacent the cable. One or more elongated flexible connectors extend from the sheet. Each connector is attached, by one portion thereof, to the sheet. Each connector also has a

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free end portion distal of the said sheet. The free end portion is wrapped one or more times about the cable after wrapping. Means are provided for fixing the terminal portion of the connector extending from the cable to the sheet to maintain the sheet connected to the cable.

The cable may be located adjacent the surface of the sheet with the connectors extending from the sheet surface, wrapped about the cable and attached at their free ends back to the sheet.

The cable may also be located adjacent the edge of the sheet with a second sheet, having connectors, opposite the first sheet and adjacent the cable. The connectors of both sheets are wrapped about the cable and their terminal portions connected to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature and objectives of the invention, reference is made to the accompanying drawings showing by way of example specific embodiments thereof and in which:

FIG. 1 is a cut-away plan showing the progressive stages of the connection and the top closure of one form of structural assembly.

FIG. 2 is a cross-section of the structural assembly of FIG. 1 showing a completed connection and also top and bottom closures.

FIG. 3 is a cross-section and sectional plan of a further embodiment of the structural assembly.

FIG. 4 illustrates another embodiment of the invention using wires or small cables to attach the sheets to support cables, and

FIG. 5 illustrates a connecting means used to connect the wires to the support cable.

DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in FIG. 1, flexible enclosure sheets 2 and 3 are connected to an elongated support means 1 to form a roof structure. The elongated support means 1 preferably comprises a cable supported parallel to or angularly with respect to the ground by posts. The manner in which the cable is supported is not important to an understanding of the invention. The flexible enclosure sheets 2 and 3 are large rectangular sheets which can be of plastic or coated fabric material. For the purpose of describing the assembly of the sheets to the cable, sheet 2 will hereafter be known as the "foregoing" sheet, which is the sheet first connected to the cable, and sheet 3 will hereafter be known as the "follow-up" sheet, which is the second sheet to be connected to the cable after the connection of the foregoing sheet 2 to the cable. Each of the flexible sheets 2 and 3 can, to provide greater strength and insulation, comprise two sheets 21, 22, one on top of the other with an air space located therebetween to provide insulation as shown more clearly in FIG. 2. Both the foregoing sheet 2 and the follow-up sheet 3 are provided with flexible connectors 23 for attaching the sheets to the cable. The connectors can comprise small cables, wire or straps attached to the sheets 2 or 3. As shown in FIGS. 1 and 2 the connectors comprise flexible straps 6 and 7 attached at one end to their respective sheets 2 and 3 and extending transversely from the edges 24 and 25. The straps have a free end portion distal of the sheets. In one preferred form, as shown in FIGS. 1 and 2, the straps 6 and 7 are formed from reinforcing pieces 4 and 5 attached to the foregoing and follow-up sheets 2 and 3 respectively adjacent their edges 24, 25. The reinforcing sheets can be of the same material as the sheets 2, 3. The free edges of the reinforcing sheets 4 and 5 can be cut in scallop form as shown in FIG. 1 to provide a plurality of straps 6 and 7 extending therefrom. The scallop-shaped edge provides a stronger connection between

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the free ends of the straps and their connection to the reinforcing sheets than would be provided if the straps extended from a straight edge of the reinforcing sheet since stress locations are minimized. The straps 6 and 7 are spaced apart and made of a width to provide the necessary strength to support the sheets from the cable.

To form the structural assembly, the foregoing sheet 2 is positioned adjacent the cable 1 and the free end portions of straps 6 are wrapped spirally in one direction around the cable one or more times with a terminal portion 26 extending from the cable after wrapping. The terminal portion 26 of the strap is then temporarily connected back to the foregoing sheet 2 or the reinforcing sheet 4 by means of a clamp 8. The number of times the strap is wrapped or wound around the cable depends on the frictional resistance of the cable surface. To reduce wear of the straps the use of cables covered by PVC or similar material is recommended.

Subsequently to the temporary connection of the free end portions 26 of the straps 6, the follow-up sheet 3 is positioned adjacent the cable but opposite to the foregoing sheet 2. The straps 7 are located so that when the sheets 2, 3 are in position, the straps are spaced laterally a slight distance, such as 2 or 3 inches, from the straps 6. The free end portion of each strap 7 is then wrapped spirally around the cable in a direction opposite to the direction of wrapping strap 6 and toward the adjacent strap 6. The terminal portion 26 of the strap 6 can then be connected or attached by connection means 10 to the terminal portion of strap 7 thereby locking the straps together and maintaining the foregoing and follow-up sheets 2, 3 in place on the cable 1. Cooperating male and female snap fasteners forming connection means 10 may be attached to the terminal portions of the straps 7 and 6 to facilitate their connection. The female snap fastener 9 on strap 6 is shown in FIG. 1. The wrapping of the straps 6 and 7 in opposite directions about the cable and then connecting them together provides frictional resistance for holding the straps and thus the foregoing and follow-up sheets 2 and 3 to the cable. The weight of the sheets pulling on the straps tend to tighten their hold about the cable so as to prevent the straps from loosening and un-locking. The loose terminal portion of the strap 6 extending outward of snap fastener 9 may, after its connection to the terminal portion of strap 7, be cut off or just left dangling over the completed connection 10.

The structure described can form the roof of a building with the edges of the enclosure sheets 2, 3 opposite to edges 24, 25 attached to the side walls of the building structure or attached to the ground.

FIGS. 1 and 2 illustrate the connection of two sheets to a central cable. A plurality of parallel cables could be provided with sheets positioned between adjacent cables and connected to the cables as shown in FIGS. 1 and 2 to form roofs with large spans.

While the strap members 6, 7 shown in FIG. 1 have been integrally formed from the reinforcing sheets 4 and 5 on the edges of the foregoing and follow-up sheets, they can also be integrally formed directly from the sheets themselves adjacent edges 24, 25, if the sheets are made of strong enough material to carry the weight of the sheet when connected to the cable in forming a roof structure. While not essential, it is preferred that the strap members be cut from the material in a scalloped pattern, as shown in FIG. 1, in order to reduce the tendency of the straps to tear away from the sheets.

Subsequent to the completion of the structural connections 10 attaching the sheets to the cables a weatherproof closure can be provided. The closure preferably is a top closure, as shown in FIG. 2, and comprises a first top sheet 12 connected to the foregoing sheet 2, a second top sheet 11 connected to the follow-up sheet 3 and a weatherproof connection 13 formed between the free end edges of the top sheets 12 and 11. The top sheets 11 and 12 may be integrally formed from the reinforcing sheets 3, 4, if such

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are used and bent double therefrom, as shown in FIG. 2, to form the top closure. Alternatively, they can consist of separate sheets bonded to the foregoing and follow-up sheets adjacent the reinforcing sheets 4 and 5, or adjacent the edges 24, 25, of the foregoing and follow-up sheets 2 and 3. The free edge of the top sheet 12 extends over the cable and the structural connection of the sheets to the cable and meets the free end edge of the opposite top sheet 11 where the two end edges are interfolded and connected together. The connection 13 may be effected by either stapling or clamping the interfolded sheets at close intervals or by the application of continuous elastic compressors such as split plastic pipes or by other means to form a weathertight connection.

A bottom closure can also be provided. The bottom closure, as shown in FIG. 2, consists of bottom sheets 14 and 15 and a connection 17 joining their free edges together and is in principle identical to the top closure except that the bottom sheet 15 can be very short and the connection 17 need not be waterproof. The bottom sheet 14 must be wide enough and loose enough so as not to become stressed under uplift conditions of the foregoing and follow-up sheets 2 and 3 due to wind. The enclosed air volume 16 above the bottom sheets 14 and 15 provides insulation and in addition the bottom closure contributes a neat appearance to the roof as seen from the inside.

FIG. 3 illustrates a further embodiment of the structural assembly for supporting a sheet intermediate its ends. Intermediate supports are required if the spacing between a plurality of cables is less than the width of the sheets available or to provide additional strength to the roofing or side structure to more evenly distribute the load on the roof. The intermittent cable further helps to maintain the sheet in a fixed position and reduces the possibility of uplift or the sheet under windy conditions. In this embodiment the sheet 27 being either a single or double layer of material, is located adjacent the cable 28. Preferably, the sheet 27 overlies the cable 28. A connector 29, extending from the inner surface of the sheet, is wrapped about the cable and then attached to the sheet. The connector 29 can again comprise a strap 18 attached at one end 19 by bonding or other means to the inner surface of the sheet. The free end portion of the strap extending from the sheet is wrapped or wound about the cable the necessary number of times to provide sufficient frictional holding strength with the terminal portion 30 of the strap extending from the cable after wrapping, being connected back to the inner surface of the sheet. The connection can be by means of a snap fastener 20, as shown in FIG. 3, or by other means. This arrangement will not only reduce undesirable secondary stresses but cause primarily axial tension in the sheets and in the straps and will not tend to cause opening of the connector means under uplift conditions. The spacing of the connectors along the length of the cable is determined by structural requirements.

FIGS. 4 and 5 illustrate a further embodiment of the invention using wires or small cables as the flexible connectors for attaching the sheets to the support cables. Each of the sheets 31, 32 connected to support cable 33 can comprise a single relatively thick sheet of plastic or coated fabric material or a plurality of thinner sheets of plastic or fabric material laminated together. If laminated plastic or fabric sheets are used the flexible connectors for attaching the enclosure sheets 31, 32 to the support cable can comprise a plurality of spaced apart wires or small cables 34 laminated between the outer and inner sheet layers 35, 36 forming each enclosure sheet 31, 32. The wires 34 extend across the width of each sheet 31, 32 and having a free end portion projecting transversely from the edges 37, 38 of the sheets 31, 32 located adjacent the support cable 33. The terminal portion 39 of the free end portion of each wire 34 have a connecting means 40 attached to it. The connecting means 40 comprises a fixture having a split-clamp end

portion 41 for attachment to the terminal end 39 and a free hook-end portion 42.

To attach the sheets 31, 32 to the support cable 33 by the wires 34, the free end portion of each wire is wrapped about the support cable one or more times and its terminal portion 39 is attached to the free end portion by the hook portion 41 of the connector means. The wires 34 in sheet 31 are offset from the wires in sheet 32 when the sheets 31, 32 are located adjacent cable 33 to permit easy installation. The weight of the sheets 31, 32 pulling down from the support cable 33 will tighten the wrapped wires 34 about the cable 33 providing a firm grip to hold the sheets in place. The use of a hook type connecting means permits the sheets, wires and connecting means to be assembled off the site so that only installation of the sheets with the wires to the set-up support cable or cables is necessary when constructing a building. The connecting means 40 can comprise other types of fixtures than that shown. For example, a double clamp can be used to clamp the terminal portion 39 of the wire to itself.

While the wires or small cables 34 have been described as being laminated between the inner and outer sheets 35, 36, they could also be totally or partially embedded in the sheets 31, 32 if these sheets are thick and/or of a single layer. If partially embedded, the wires would be on the inner surface of the sheet. Alternatively, the sheets 31, 32 could be laid directly on top of the spaced apart wires 34, with the sheets connected to the wires by wire stitching or other means.

The structure shown in FIG. 4, when used as a roof, can be made weathertight using top and bottom closures similar to those shown in FIGS. 1 and 2.

The support members 1, 28 and 33 in the different embodiments of the invention shown in the drawings have preferably comprised cables. However, the support members could also comprise steel wires, rope or other flexible members strong enough in tension to carry the roof load provided by the sheets and useful when constructing small buildings. The support members could also comprise relatively inflexible rods or tubular members such as pipes for short spans.

I claim:

1. A structural assembly comprising an elongated support means, a flexible sheet located adjacent said support means with said support means being adjacent the surface of said sheet, and at least one elongated connector extending from said sheet, each said connector having a first end portion attached to said sheet and a free end portion distal of said sheet, the free end portion of said connector being wrapped at least one turn about said support means with a terminal portion thereof extending from said support means after wrapping, and means fixing said terminal portion to said sheet whereby to maintain said sheet connected to said support means.

2. A structural assembly as claimed in claim 1, wherein each connector comprises a strap attached at one end to the sheet, and wherein the fixing means comprise cooperating means on the terminal portion of the strap and on the sheet for connecting the terminal portion of the strap to the sheet after it has been wrapped about the support means.

3. A structural assembly comprising an elongated support means, first and second flexible sheets positioned on opposed sides of said support means, each sheet having an edge located adjacent the support means, one or more elongated connectors extending from the edge of each sheet, each connector having a first portion thereof attached to its respective sheet and a free end portion distal of the sheet, the free end portion of each connector wrapped at least one turn about the support means with a terminal portion extending from the support means after

wrapping and means connecting the terminal portion of each connector to its free end portion.

4. A structural assembly as claimed in claim 3 wherein each connector comprises a strap portion integrally formed from, and extending transversely from, the edges of the first and second sheets.

5. A structural assembly as claimed in claim 3 wherein each of the connectors comprises a strap portion cut from a reinforcing member connected to each of the first and second sheets.

6. A structural assembly comprising an elongated support means, first and second flexible sheets positioned on opposed sides of said support means, each sheet having an edge located adjacent the support means, one or more elongated connectors extending from the edge of each sheet, each connector having a first portion thereof attached to its respective sheet and a free end portion distal of the sheet, the free end portion of each connector wrapped at least one turn about the support means with a terminal portion extending from the support means after wrapping and means connecting the terminal portion of each connector to an adjacent terminal portion of a connector extending from the opposite sheet.

7. A structural assembly as claimed in claim 6 wherein the free end portion of each connector on the first sheet is wrapped about the support means in one spiral direction and the free end portion of each connector on the second sheet is wrapped about the support means in an opposite spiral direction.

8. A structural assembly as claimed in claim 6 including a top closure for the structural assembly consisting of a first top sheet which is attached at one edge adjacent the edge of the first sheet and extends outwardly therefrom, a second top sheet which is attached at one edge adjacent the edge of the second sheet and extends outwardly therefrom toward the first top sheet, and means for joining the free end edges of the first and second top sheets to each other to form a weatherproof closure for the structural assembly covering the support means.

9. A structural assembly as claimed in claim 6 including a bottom closure consisting of a first bottom sheet connected to the inner surface of the first sheet adjacent its edge, a second bottom sheet connected to the inner surface of the second sheet adjacent its edge, and means connecting the free edges of the first and second bottom sheets together.

10. A structural assembly as claimed in claim 6, wherein the first portion of each of the connectors attached to the sheets extends across the width of each sheet, and each connector comprises a wire member.

11. A structural assembly as claimed in claim 10 wherein the connecting means comprises a clamp fixture attached to the terminal portion of each wire member, the clamp fixture having a hook to connect the terminal portion to the free end portion.

12. A structural assembly as claimed in claim 10 wherein each sheet comprises two or more sheet layers laminated together with the wire members located between the layers.

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U.S. Cl. X.R.

52—222, 582; 135—15; 160—389